ENVIRONMENTAL MANAGEMENT CONTROL

An Empirical Study on the Use of Environmental Performance Measures in Management Control Systems

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An Empirical Study on the Use of Environmental Performance Measures in Management Control Systems

Een wetenschappelijke proeve op het gebied van de Managementwetenschappen

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TABLE OF CONTENTS

CHAPTER 4 SURVEY RESEARCH METHOD AND DESCRIPTIVE STATISTICS

CHAPTER 5 SURVEY RESULTS

CHAPTER 6 CASE STUDY

CHAPTER 7 CONCLUSIONS AND DIRECTIONS FOR FURTHER RESEARCH

Appendices

CHAPTER 1
INTRODUCTION

1.1 Background of the study

Over the last decade, an increasing number of companies have integrated the environmental aspects of their operations and services into their daily business practices (Schot and Fisher, 1993; Hart, 1997; Berry and Rondinelli, 1998; Hoffman, 1999a; Starik and Marcus, 2000; Morrow and Rondinelli, 2002). The concern of companies on ecological matters has shifted away from an approach of regulatory compliance that was typical of the Seventies and the Eighties (Gladwin, Kennelly and Krause, 1995; Hoffman, 1997; Kolk, 2000). Instead, there is growing evidence that corporations anticipate regulatory compliance and reduce waste and pollution in advance of regulation (e.g. Reinhardt, 1999a, 2000; Prakash, 2001; Holliday, Schmidheiny and Watts, 2002). The more environmentally-oriented companies are even going beyond pollution control strategies and explore new opportunities for the development of "green" technologies (e.g. Klassen, 2000) and "green" products (e.g. Pujari, Wright and Peattie, 2003). In addition, industrial associations, governmental and international organizations produced a series of standards that corporations can use as guidelines and benchmarks for their environmental management systems (King and Lenox, 2000). Among these standards, the most diffused is ISO 14001, which provides a managerial framework by which an organization can design an environmental management system that identifies an organization's environmental policy, the environmental aspects of its operations and a set of clearly defined objectives for environmental improvement (Murray, 1999; Delmas, 2001). The adoption of ISO 14001 is exponentially growing worldwide with about 74,000 certifications as for October 2004, while they amounted to 47,000 in December 2003 (ISO World, 2004).

"Greening of business" refers to a combination of business principles and practices about environmental management and social responsibility that can be hardly summarized under a precise definition. The label overlaps with terms like sustainability and, more recently, corporate social responsibility that remain open to various interpretations. I will refer to the term "greening" in this introductory chapter, while in Chapter 2 I will be more explicit about dimensions of "greening" that will form the object of this dissertation. Despite the proliferation of labels surrounding this area, it is noteworthy that "greening" has pervaded different industrial and service sectors. In fact, ecological issues cannot be confined to the manufacturing sector in which environmental aspects have been traditionally considered as a key societal concern. For instance, an increased number of banks have adhered to, so-called, Socially Responsible Investing (SRI) initiatives in the financial sector (EUROSIF, 2003; SIF, 2003; The Global Compact, 2004). The spread of environmental and social information about companies has been prompted by the diffusion of private research firms that specialize in the collection and provision of "sustainable profiles" to banks, insurers and institutional investors. Among the most well known SRI ranking indexes, the *Dow Jones Sustainability Index* and the *FTSE4Good Index* provide benchmarks and orientate investment in companies with positive records of social and environmental performance. Growing attention from the financial community is also directed towards the creation of greenhouse gas markets, particularly in light of current developments in international climate change policy (see Pew Center on Global Climate Change, 2002; IRRC, 2003).

Thus, it appears that the trend towards "greening" has received added impetus from a combination of organizational factors and institutional changes, the latter comprising for instance growing stakeholder activism, revised stock exchange requirements for environmental disclosure and negative public reaction to environmental accidents (Bansal and Roth, 2000). Companies and managers are under increased pressure to demonstrate high levels of organizational performance not only in terms of competitiveness, market growth and (short-term) financial results, but also with regard to their (long-term) environmental performance and sustainability (Epstein and Birchard, 1999; Eccles, Herz, Keegan and Phillips, 2001; Kaplan and Norton, 2003). In February 2004, the survey results released by the Global Environmental Management Initiative (GEMI, 2004), based on earlier research by Cap Gemini Ernst & Young (Cap Gemini Ernst & Young, 1996, 1999), came to the conclusion that:

- 50 to 90% of a firm's market value can be attributed to intangibles like Environmental, Health and Safety (EHS) performance;
- 35% of institutional investors' portfolio allocation decisions are based on intangibles like EHS performance;
- 81% of Global 500 executives rate EHS issues among the top ten factors driving value in their businesses.

Another recent survey (PriceWaterhouseCoopers, 2004a) highlighted the following results from a sample of 1,400 CEOs of multinational corporations operating in 40 countries:

- 67% disagreed with the statement that sustainability is largely a public relations issue, up from 50% in 2002;

- 79% agreed that sustainability is vital to the profitability of any company, up from 69% in 2002;
- 68% disagreed with the suggestion that the current economic climate will render sustainability a lower priority, compared to 60% in 2002;
- 71% of CEOs agreed that, when implementing a sustainability programme in their organizations, they would consider sacrificing short-term profitability, if necessary, in exchange for long-term shareholder value.

From these highlights, it appears that "greening" is moving beyond the boundaries of legal compliance and corporate philanthropy and starts to occupy a more central position in business management alongside conventional strategic issues (cf. Epstein, 1996; Kolk, 2000; Reinhardt, 2000).

In response to these recent developments, new forms of accounting and accountability practices have been proposed, suggesting a more central role of measurement and reporting of social and environmental aspects of business activities (Cormier and Gordon, 2001; Gray and Bebbington, 2001). In a similar vein, extended models of corporate governance have been proposed since firms are increasingly held accountable not only to their shareholders, but also to the broader community of stakeholders who are affected by firms' decisions (cf. Bradley, Schipani, Sundaram and Walsh, 1999; Margolis and Walsh, 2003; Sacconi, 2004). To help establish or increase corporate accountability, a new "reporting industry" which provides information on social and environmental performance of firms is slowly developing (Collison and Slomp, 2000; ACCA, 2001; Kolk, Walhain and van de Wateringen, 2001; Epstein, 2003). Latest surveys of practice suggest that there has been a significant increase in the number of companies issuing environmental, social or sustainability reports in addition to, or within, their traditional financial reports. In 2002, 45% of the Global Fortune 500 companies and 28% of the Top 100 companies produced these type of reports, compared to 35% and 24% respectively in 1999 (KPMG/UvA, 2002). Principles and guidelines about reporting financial, environmental and social performance (also known as the "Triple Bottom Line") are increasingly available to ensure convergence and standardization of reporting practices worldwide (e.g. GRI, 2002). Proposals on how to best measure performance against the goal of sustainable development are produced by several subjects, ranging from environmental non-governmental organizations (NGO's) to industrial associations or a combination of them. In this respect, the implications for auditing and verification of environmental reports are also expected to rise, as an innovative form of assurance services that integrate the conventional portfolio of activities in auditing firms (Beets and Souther, 1999; Wallage, 2000). The survey by PriceWaterhouseCoopers (2004a) previously mentioned also reported that one-third of the surveyed companies providing environmental-related information had this data verified externally. Furthermore, 46% of the respondents indicated that sustainability reporting should become a mandatory practice.

Within the wider developments of "greening" affecting accounting practices, the field of *corporate environmental accounting* encompasses activities that range from accounting for contingent liabilities, through cost analysis and capital budgeting for environmental investments, to external reports about environmental activities and related costs (Ansari, Bell, Klammer and Lawrence, 1997; Epstein and Roy, 1997; Bennett and James, 1998c; Bennett, Bouma and Wolters, 2002a). Among others, Schaltegger and Burritt (2000:58-63) proposed a framework in which a distinction should be drawn between conventional accounting practices, focused on financial (monetary) impacts of environmental management and based on the classic distinction between financial versus managerial accounting; and ecological accounting, centred instead on environmental (physical/non-monetary) impacts. The definition of the discipline of environmental accounting that they provide is the following:

> *"Environmental accounting is a sub-set of accounting that deals with: activities, methods and systems; recording, analysis and reporting; and environmentally induced financial impacts and ecological impacts of a defined economic system (e.g. a firm, plant, region, nation, etc.)"*.

Within the broad environmental accounting field, the area of "environmental management accounting" (EMA) has been introduced in the mid-Nineties. Among the definitions available, the International Federation of Accountants proposed that EMA consists of (IFAC, 1998:3):

> *"…the management of environmental and economic performance through the development and implementation of appropriate environment-related accounting systems and practices. While this may include reporting and auditing in some companies, environmental management accounting typically involves life-cycle costing, full cost accounting, benefits assessment, and strategic planning for environmental management"*.

EMA has received increased attention from practitioners in the past years, mainly because of the monetary consequences of environmental impacts and incidents under the forms of remediation costs or past liabilities (Ansari *et al.*, 1997; Bennett and James, 1998b, 1998c; Schaltegger and Burritt, 2000). International government agencies (United Nations, 2000, 2001) or accounting professional bodies (e.g. IFAC, 1998; CICA, 2001; CIMA, 2002; ICAA, 2003; IFAC, 2004) have promoted the diffusion of EMA. A range of tools are available for managers derived from traditional management accounting techniques (Epstein, 1996; Grinnell and Hunt, 1999; Parker, 2000a; Burritt, 2004). The interest surrounding EMA and its increased adoption have been confirmed by surveys of practice in different countries (Ditz, Ranghanathan and Banks, 1995; Bartolomeo, Bennett, Bouma, Heydkamp, James and Wolters, 2000). However, academic research about this new field within mainstream management accounting research remains undernourished. It can be concluded that most of the literature about EMA has a prescriptive tone and it is often based on anecdotal evidence, which is typical of any novel field. The next two sections motivate further the need to develop theory-driven research around EMA as field of study and specify the research objectives of this dissertation.

1.2 Motivation of the study

Although the importance of EMA practices has been recognized from the practitioner's literature, much remains to be explained as to why, how and with what effects companies implement these practices. Therefore, *this dissertation aims to examine the role and the implications of management accounting and control in environmental management.* Three reasons can be forwarded to substantiate the choice of this research topic. First, the dissertation acknowledges that there has been an unbalanced interest in accounting research concerning environmental management and environmental accounting. As I will illustrate in Chapter 2 when reviewing the literature on accounting in relationship with "greening", accounting researchers have so far focused on the external aspects of environmental accounting practices. The studies developed in the area examined determinants and effects of environmental disclosures. The increased accessibility of data from publicly available corporate environmental reports, or databases prepared by rating agencies that was briefly mentioned in the previous section, explains the rising amount of empirical research in this area. Findings from this literature indicate in general that investors do take into account voluntary environmental disclosure or information that is accessible from external sources. In addition, it appears that environmental-related information disclosed as a result of accounting standards requirements is also value relevant, even though some studies have raised concerned about the reliability of that information (cf. Berthelot, Cormier and Magnan, 2003). While this type of research advanced our knowledge on the use and effects of environmental-related information for external purposes, studies which focused on *internal*, managerial accounting uses of the same information are still in early development. Much remains to be explained about determinants and effects of EMA and its relation to traditional management accounting and control systems. Recent calls have been made to foster management accounting research in the area of environmental management (Shields and Boer, 1997; Grinnell and Hunt, 2000; Gray, 2002; Berthelot *et al.*, 2003; Epstein, 2003). Overall, these calls underscore the need of descriptive and explanatory studies in an area still dominated by normative and practitioner's oriented literature. This project attempts to respond to the lack of scholarly research in this novel field. Hence, this dissertation addresses a gap in the accounting literature and seeks to enhance our understanding of a relative novel domain.

Second, in this dissertation I argue that the conceptual and practical issues about EMA broadly overlap with those investigated in the field of management accounting and control. Underlying is the assumption that *measurement* aspects regarding the design of accounting and information systems in environmental management can be appropriately examined by referring to extant knowledge in performance measurement and management control from mainstream studies. The same rationale applies to the *management* aspects associated with EMA implementation, where different theoretical insights can be used to understand the dynamics of performance measurement and control system change. Given the novelty of EMA as field of research (Lanen, 1999; Wisner, Epstein and Bagozzi, 2002; Pondeville, 2003), this dissertation will therefore refer to extant literature in management accounting and control. In particular, in the current exploratory phase the study draws upon prior research about the link between management accounting and quality management to guide the investigation around EMA (e.g. Daniel, Reitsperger and Gregson, 1995; Ittner and Larcker, 1995, 1997; Perera, Harrison and Poole, 1997; Van der Stede, Chow and Lin, 2003). Chapter 2 will clarify and elaborate the analogy in terms of principles and techniques between environmental management and quality management as contiguous practical domains. At the same time, EMA presents a peculiar empirical setting due to the interplay among internal and external factors that shape design and effects of performance measurement and control systems. In brief, I argue that the study of EMA allows discussing theories and empirically examining phenomena that are at the core of management accounting and control research.

Third, and in strong connection with the previous point, I posit that EMA provides a challenging empirical setting regarding the evolution of the field of management accounting and control. In their renowned review of the historical evolution of management accounting systems, Johnson and Kaplan highlighted many of the deficiencies in the way in which management accounting information is used to manage businesses (Johnson and Kaplan, 1987). While financial information remains the overriding goal, it is considered insufficient to reflect other relevant dimensions of organizational performance (cf. Ittner and Larcker, 1998a; Ittner and Larcker, 2003). The shortcomings of traditional performance measurement systems have triggered a change in performance measurement, and several performance measurement "innovations" has been recently advanced to overcome the perceived limitations of traditional financial measures (cf. Ittner and Larcker, 1998b; Waterhouse and Svendsen, 1998; Meyer, 2002; Neely, 2002). Among others, performance measurement models include the SMART pyramid (Lynch and Cross, 1991), the Balanced Scorecard (Kaplan and Norton, 2000), strategic performance measurement and control systems (Simons, 2000) and the Action-Profit-Linkage (APL) model (Epstein, Kumar and Westbroek, 2000). The objective of such frameworks is claimed to help companies define a set of measures that more appropriately reflect their strategic objectives and assess their performance. At the core of the innovations discussed, is the premise that the scope of management accounting needs to shift away from mere financial dimensions of performance to encompass non-financial measures. As recent scholarly reviews have confirmed, the field of management accounting and control is evolving (e.g. Hartmann, 2000; Ittner and Larcker, 2001; Otley, 2001; Chenhall, 2003; Otley, 2003). The traditional notion of management control embedded in the cybernetic control model of the Fifties is no more suitable nowadays. In this dissertation, I propose that EMA represents a challenging area of debate around the evolving role of management accounting and control. To paraphrase Miller (1998), EMA can be currently considered at the "margins of accounting", being peripheral to traditional accounting principles and practices. EMA provides thus an empirical setting that might inform the debate about present and future of management accounting at large. This novel area at the "margins" represents a promising area of research as emphasized by Miller (1998):

> *"Accounting is most interesting at its margins. For it is at the margins that we see new calculative practices added to the repertoire of accounting. … It is at the margins that accounting intersects with, and comes into conflict with, other bodies of expertise. And it is at the margins that accounting comes to be linked up to the demands, expectations, and ideals of diverse social and institutional agencies".*

In fact, it appears that management accounting field is subject to evolution, as reported in recent surveys carried out in Europe and Unites Stated among controllers and CFOs on the future of their professions (IMA, 1999; IFAC, 2001, 2002). It is relevant to explore whether this evolution has informed the area of environmental performance measurement and reporting as well, and what are the repercussions on the controller's profession (cf. CIMA, 2002).

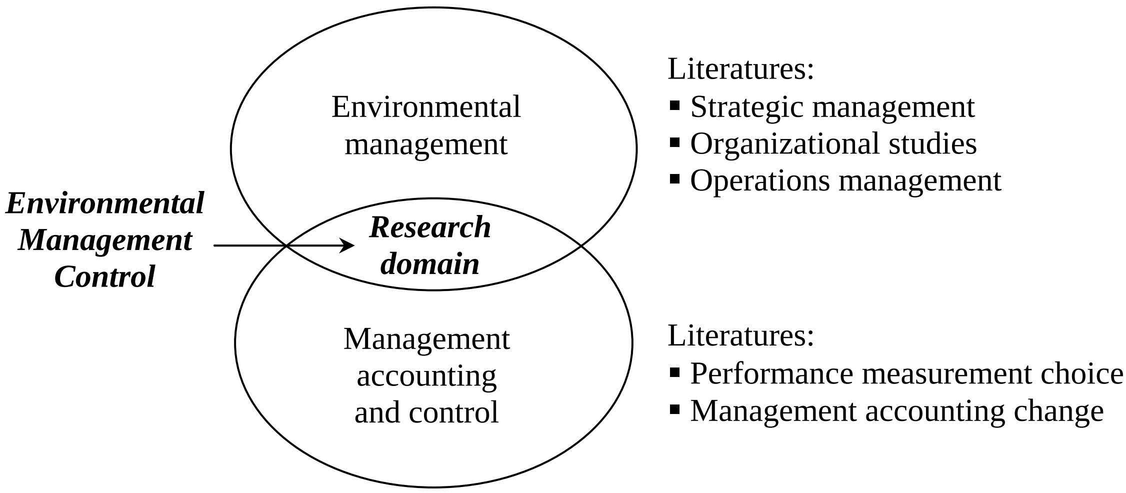
In sum, this dissertation is focused around EMA and follows three extant debates in scholarly research in management accounting and control. The first debate is located within the area of environmental accounting as a novel area of research. I focus on management accounting as one of the sub-areas in environmental accounting research relatively unexplored, particularly if compared with financial accounting studies. The second debate considers EMA as an empirical field in which extant theories and empirical findings from prior research in management accounting and control can be fruitfully applied. In particular, quality management is identified as a contiguous area to environmental management, from which theoretical underpinnings and empirical insights are drawn and adapted to EMA as an innovative field. The third debate is framed over EMA as an emblematic area at the margins of accounting. The investigation of EMA as a novel research domain allows a broader discussion about the current evolution of (management) accounting field and its potential role in the future. Taken together, these three debates delimit the research area and the contributions of this dissertation. The next section specifies the research domain and the problem definition of the study.

1.3 Research scope and objectives

As portrayed in Figure 1.1, the research domain of this dissertation is located at the interface of two academic disciplines. The first domain is labelled as environmental management and focuses on the theoretical and empirical interactions of organizations with the natural environment. The field appears as a *"gathering of theoretical streams"* (Sharma, 2002:3), since scholarly researchers have attempted to explain the interactions at various levels of analysis applying several theories grounded in their own disciplinary traditions. This dissertation pivots on three areas of research in business management that have examined the environmental responsiveness of organizations. The literatures in strategic management, organizational studies and operations management will be scrutinized and will contribute to investigate the research domain. The second field comprises management accounting and control research, a more established area within the accounting discipline. Among the definitions that were proposed to characterize the field, Ittner and Larcker (2001:355) recently noted that:

> *"Managerial accounting and control should be viewed as a complete organizational control package consisting of accounting information systems, performance measurement and reward systems, and organizational design, with the choice and performance consequences of these practices a function of the firms' external environment, organizational objectives, and strategies".*

Figure 1.1 – Research domain and bodies of literature



The label *environmental management control* can be used for this study to demarcate the research domain of this dissertation. Drawing upon the definition of Simons (2000:4) about traditional management accounting and control systems, *environmental management control* consists of a package of formal, information based-routines and procedures that managers use to maintain or alter patterns in organizational activities specifically concerning the environmental aspects of organizational performance. The purpose of this dissertation is to explore determinants and effects of environmental management control systems. In particular, the element within management control systems (MCS)[1] that will be explicitly object of investigation in this dissertation is environmental performance measurement. In brief, performance measurement systems assist managers in tracking the implementation of business strategy by comparing actual results against strategic goals and objectives (Simons, 2000:7).

The purpose of this dissertation is to explore determinants and effects of environmental management control systems. In particular, the element within management control systems (MCS) [1] that will be explicitly object of investigation in this dissertation is environmental performance measurement. In brief, performance measurement systems assist managers in tracking the implementation of business strategy by comparing actual results against strategic goals and objectives (Simons, 2000:7). Management control theory argues that MCS are intended to ensure that employees (1) know what is expected of them, (2) will exert effort to do what is expected, (3) are capable of doing what is expected, and (4) accomplish what is expected (cf. Merchant and Van der Stede, 2003). As anticipated in the previous section, performance measurement issues are receiving increasing attention as organizations attempt to implement new measurement systems that better support organizational objectives (Bruns, 1992; Ittner and Larcker, 1998b; Meyer, 2002; Kennerley and Neely, 2003). During the Nineties, environmental performance measurement systems acquired increased importance in the management and improvement of the environmental impacts of business. Greater attention has been paid to environmental-related information to comply with regulation and meet the demands of ever more sophisticated stakeholders through environmental reporting. More recently, the diffusion of EMA has emphasized the need of relying upon better environmental performance measures for internal decision-making and control. In this dissertation I maintain that many of the issues and challenges that apply to business performance measurement can be replicated to the novel field of environmental performance measurement. Therefore, the empirical studies of this dissertation rely upon and contribute to the literature in management accounting and control that examined performance measurement choice (cf. Merchant, Van der Stede and Zheng, 2003).

Three research questions are addressed in the dissertation. First, the dissertation investigates the *determinants* of the use of environmental performance measures for internal control and external accountability. The objective is to explain variation in extant performance measurement design with regards to environmental-related information. Anecdotal evidence suggests that companies experience different stages of adoption and use of environmental performance measurement systems (Epstein, 1996; Bennett and James, 1998a; Reinhardt, 2000). This study develops a conceptual model that addresses antecedents of the design and use of environmental performance measures in MCS. Specifically, the model examines the relationships among variables concerning environmental strategy implementation, informational attributes of environmental management information system and use of environmental performance measures. Hypotheses are developed concerning a set of theoretical paths that build upon contingency-based as well as economics-based studies in management accounting research. Therefore, the first research question can be formulated as follows:

RQ1a *What factors explain the use of environmental performance measures in management control systems?*

A complementary theme related to performance measurement is concerning the use of environmental performance measures for external *versus* internal purposes. As I will elaborate in Chapter 2 in the literature review, a debate has developed in the literature about environmental accounting from researchers adopting an institutional or legitimacy perspective about the use of performance measurement systems. To put it briefly, institutional theories maintain that organizations gain legitimacy by conforming to external expectations regarding organizational practices, while separating (or de-coupling) their internal activities from the externally-focused symbolic systems (Meyer and Rowan, 1977; DiMaggio and Powell, 1983; Meyer, 1986). When applied to the environmental management field, this issue is particularly relevant: organizational changes that substantiate only in ceremonial adaptation without being incorporated into organizational structure and systems have been labelled as “window dressing” or “greenwashing” (Greer and Bruno, 1998). Thus, the diffusion of environmental performance measurement systems requires to empirically examine the potential faddish nature of environmental performance measurement systems. This evidence would also add to recent studies in management accounting that emphasized the “measurement gap” between internal and external use of performance measures (Ittner and Larcker, 2001; Ittner, Larcker and Randall, 2003b; Abernethy and Vagnoni, 2004). I will address this issue by answering the following research question:

RQ1b *Is there consistency between the information that is disclosed externally and the environmental performance measures that are used internally for planning and control?*

Second, the study will explore the performance *effects* of the use of environmental performance measures in management control systems. Empirical evidence about the relationship about strategy and MCS on organizational performance in this area has been object of limited research (Judge and Douglas, 1998; Klassen and Whybark, 1999a; Wisner *et al.*, 2002; Melnyk, Sroufe and Calantone, 2003). It can be posited from arguments in contingency-based research that the fit between environmental strategy and the use of environmental performance measures affects a firm’s performance. Companies’ strategies that prioritize the environmental aspects of operations are posited to have enhanced effects on environmental performance, provided that they rely upon performance measures for their internal decision-making and control. Similarly to the arguments over quality management, practitioners’ literature suggests an amplifying effect of the use of environmental information in combination with environmental proactive strategy on organizational performance (Epstein and Wisner, 2001; Figge, Hahn, Schaltegger and Wagner, 2002; Holliday *et al.*, 2002). The performance effects associated with environmental management control systems will be addressed by the second research question:

RQ2 *Is environmental performance enhanced by the fit between environmental strategy and the use of environmental performance measures?*

Third, the dissertation attempts to analyze *processual* aspects that are associated with the implementation of an environmental performance measurement system. In contrast with much of the literature on performance measurement choice that has adopted a static approach to examine MCS design, I will explore organizational dynamics of management accounting change. This focus attempts to complement the first two research questions and provide a richer understanding of adoption and implementation of environmental performance measures. These issues are captured by the third research question:

RQ3a *How do processual aspects of management accounting change affect the integration of environmental performance measures in traditional management control systems?*

RQ3b *What is the role of the accounting and control function in the integration process?*

This question will be addressed by referring to theories and empirical evidence from studies that examined the topic of management accounting change (e.g. Burns, 2000; Briers and Chua, 2001; Luft and Shields, 2003). These studies aim to explain why and how operational dimensions of performance tend to remain separate measurement and reporting systems, rather than being integrated in the financial accounting systems. In particular, I will investigate the role of accountants and controllers in the integration process. Previous studies have indicated that presently these professions are not extensively involved in the environmental accounting practices of business (e.g. Bebbington, Gray, Thomson and Walters, 1994; Gray, Walters, Bebbington and Thompson, 1995; Wycherley, 1997). Further, it appears that their limited involvement in environmental accounting activities prevails in the area of environmental reporting. This dissertation aims at gaining further insights on the contribution – or lack thereof – of the accounting and control function towards the diffusion of EMA, and environmental performance measurement in particular, as relevant element of a management control system.

1.4 Research methodology and outline of the dissertation

Using the insights gained from the literature review that will be presented in Chapter 2 as a conceptual frame of reference, the first two research questions are explored by a survey administered in The Netherlands among financial controllers employed in manufacturing companies. I relied upon this method for two reasons. First, the survey method is the most diffused approach of data collection in extant literature in management accounting and control. Second, the survey method is suitable for the investigation of naturally occurring phenomena when publicly data about the research topic are not available (Brownell, 1995; Kerlinger and Lee, 2000; Ryan, Scapens and Theobold, 2002). In addition, the survey method ensures higher external validity than experimental method and offers more opportunities for statistical generalization than case methodology (Birnberg, Shields and Young, 1990). More details about survey design and survey administration will be presented in detail in Chapter 4.

Referring to the findings of the questionnaire as input, I subsequently explore the three research questions by using insights from a longitudinal case study within a business unit of a European multinational company in the chemical sector. The case study complements the cross-sectional survey, since it allows uncovering causal patterns regarding how organizational aspects play a role in the integration of environmental performance measures within traditional MCS. Case study methodology has been suggested as a suitable approach for examining organizational phenomena in-depth, particularly in research areas like management accounting where problems in gaining access to sensitive information in contemporary organizations are recurrent (cf. Bruns and Kaplan, 1987; Birnberg *et al.*, 1990; Otley, 1999, 2003; Humphrey and Lee, 2004). On this matter, Zimmerman (2001:419-420) recognizes the increased relevance of acquiring generalizable data from organizations when he states that:

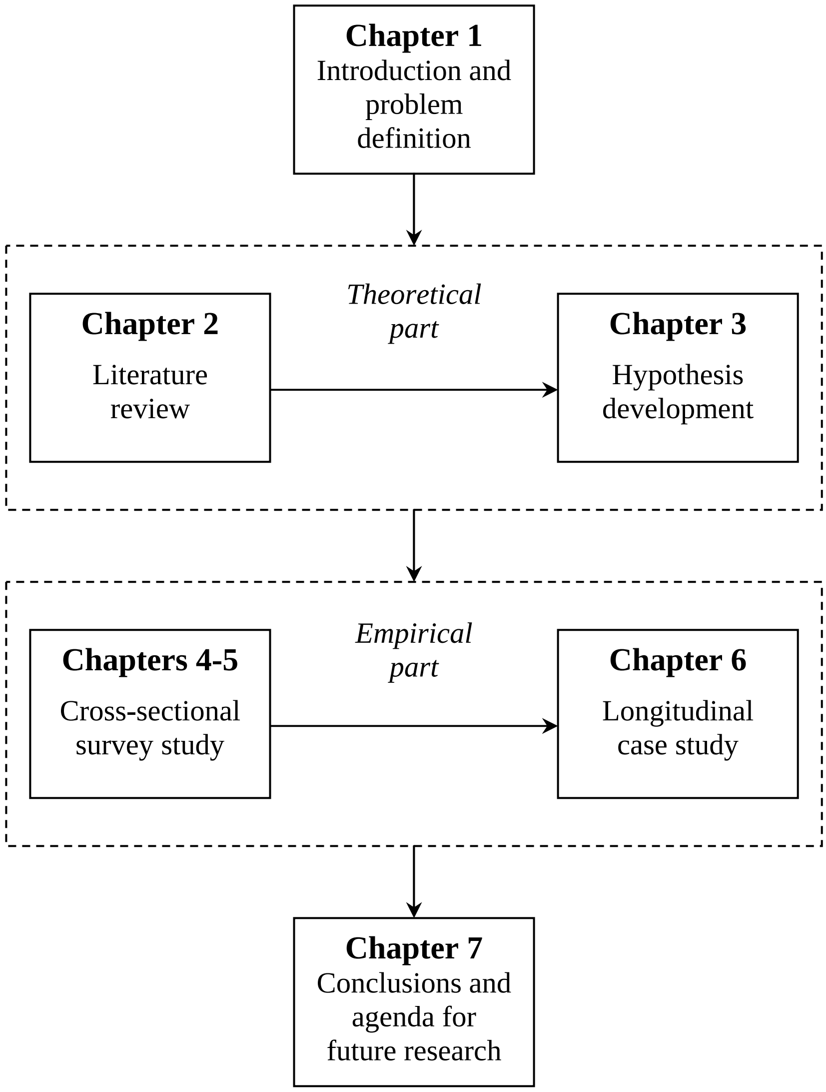
> *"…probably the single biggest factor hampering empirical managerial accounting research is the lack of consistent data about what firms do internally".*

Case studies allow researchers to infer causal relationships and to grasp theoretical patterns in their real settings (Atkinson and Shaffir, 1998; Yin, 2003). In that vein, case studies serve the purpose of exploring contemporary issues, as well as of developing and expanding theories (Eisenhardt, 1989). The first part of the case analysis provides a deductive approach of explanation that is typical of a *positivist* approach in (management accounting) research (cf. Ryan *et al.*, 2002). The objective is to expand the theoretical framework proposed at the outset of the dissertation that reflects the results from the survey-based study together with the insights collected during the field observation ('retroductive research strategy' in Blaikie, 2000:25). The second part of the analysis relies upon an *interpretative*, or *inductive reasoning*, approach (Ahrens and Dent, 1998; Baxter and Chua, 2003). Particular emphasis is given to the dynamic and processual factors that were observed in the field in relation with the implementation of a more sophisticated environmental performance measurement system. The analysis will focus on a theoretical explanation of the use of environmental performance measures that addresses management accounting change. The methodology followed to conduct the case study appears in detail in Chapter 6.

In sum, by combining a cross-sectional survey with a case study covering organizational dynamics of change, this dissertation attempts to draw some exploratory results about the use and effects of environmental performance measurement in management control systems. A case study allows the investigator to concentrate on specific instances in an attempt to identify detailed processes which may be crucial, but which might remain not specified in a large-scale survey.

The structure of the dissertation is depicted in Figure 1.2. In Chapter 2, I will review the literature in environmental management and environmental accounting. From the variety of disciplines in which “greening” has been studied, the chapter attempts to provide an organized overview about empirical studies that examined determinants and effects of environmental management. Then, I will describe the different paradigms characterizing academic research on environmental accounting. It is important to point out that specific research agendas have been pursued in this area to better position this dissertation in prior literature. Based on the review, I will emphasize that the role and the implications of management accounting and control in environmental management are only initially addressed and further research on the topic is currently needed. I will specifically motivate the focus on performance measurement as object of investigation in this dissertation. Further, existing studies in management accounting and control about performance measurement choice are scrutinized. I will rely upon recent reviews to organize the literature that traditionally separates behavioral-based studies rooted in contingency theory from economics-based literature that draws upon agency theoretic models. In Chapter 3, determinants and effects of environmental performance measurement systems are discussed and hypotheses are developed. I will develop a conceptual model that builds upon prior studies on performance measurement choice. The research method concerning design and administration of the survey carried out among a sample of financial controllers is described in Chapter 4. I subsequently present the descriptive statistics and item analysis for the variables measured with the questionnaire instrument. The formal test of the hypotheses will be presented and discussed in Chapter 5. Finally, Chapter 6 presents a field study conducted within a business unit of an international manufacturing company about the implementation of environmental performance measurement systems. The field study aims at complementing the insights of the cross-sectional survey and allows for a more in-depth analysis about the internal mechanisms driving environmental management control. By referring to the results of the survey and the insights regarding change in management accounting from the field study, I will finally draw conclusions of the dissertation in Chapter 7. The limitations of the study are summarized and research directions for further inquiries about the role and the implications of management accounting in environmental management are suggested.

Figure 1.2 – Outline of the dissertation



Endnotes Chapter 1

[1] As noted in the literature review on management control systems by Chenhall (2003:129), the terms management accounting (MA), management accounting systems (MAS), management control systems (MCS), and organizational controls (OC) are sometimes used interchangeably. The term MCS is used, in the main, throughout this dissertation.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

This chapter reviews and evaluates two broad areas of academic research that are relevant to the design and use of environmental performance measures in management accounting and control. Corresponding to the scheme presented on page 14, the first part of the chapter introduces and provides an overview of the literature in environmental management (which comprises empirical studies on "corporate greening" published in organizational and business management journals) and the literature in environmental accounting (which comprises the empirical literature in accounting research that investigated environmental-related information). The second part of this chapter focuses then on the empirical literature in management accounting research that examined performance measurement choice. The additional aim of the chapter is to explain the diversity and complexity of the research domain of environmental management control as an academic field. Hence, the chapter is more extensive than minimally required for the development of the subsequent empirical studies of this dissertation.

As the scope of these bodies of literature is extremely broad and hardly classifiable in a comprehensive review, I will summarize the main theoretical arguments and empirical evidence from these literatures as follows. The overview starts in Section 2.2.1 and Section 2.2.2 by a definition of the two research areas of environmental management and environmental accounting. The objective is to briefly introduce the two areas referring to their historical developments in practice and in academic research. In particular, I will draw a distinction between financial accounting and management accounting research, consistent with the traditional separation between the two fields in the accounting literature. More importantly, the differences between research paradigms in environmental accounting will be discussed to understand current traditions of academic research in this area. Next, a framework to organize the literatures in the two research areas is presented in Section 2.2.3. The empirical studies that examined *determinants* of environmental management and environmental accounting are briefly reviewed respectively in Section 2.2.4 and Section 2.2.5. Further, overviews of the empirical studies that examined *consequences* of environmental management and environmental accounting are presented respectively in Section 2.2.6 and Section 2.2.7. In all these review sections, I will focus on those studies in which aspects regarding design and use of environmental performance measures have been – mainly indirectly – examined. It can be anticipated from the evaluation of the literature in Section 2.2.8 that this specific theme has raised limited attention in the accounting literature as well as in environmental management. Given the novelty of the field of environmental performance measurement, I will rely upon mainstream research in management accounting and control. Section 2.3 focuses therefore on the mainstream literature in management accounting that examined performance measurement design and use. I will provide a brief overview of the literature around this topic maintaining a distinction between *behavioral*-based (Section 2.3.1) and *economics*-based research (Section 2.3.2), coherently with recent literature reviews in empirical management accounting research (cf. Ittner and Larcker, 2001; Covaleski, Evans, Luft and Shields, 2003; Merchant *et al.*, 2003). The overview is concluded in Section 2.4 with an evaluation of the management accounting and control literature about performance measurement choice and the specification of the research directions that I will follow in the remainder of this dissertation.

2.2 Empirical research in environmental management and in environmental accounting

2.2.1 Environmental management: the research area and the literature

Developments of the field

As managers have started to incorporate environmental issues into conventional strategic and operational decisions, over the last decade research interests in organizational "greening" have intensified. Initial examples of the environmental management literature appeared in books or journals whose specific theme is environmental-related, or having been written for a practitioner audience. Examples of this literature include early editions of *Business Strategy and the Environment* and journals for practitioners like *Environmental Quality Management, Corporate Environmental Strategy* and *Eco-Management and Auditing*. Much of the popular literature to date has adopted a prescriptive tone, based on anecdotal evidence that advises managers to consider the impact of environmental issues through a broad array of managerial practices. Studies in this literature tend to provide generalizations based on environmental management techniques, without substantiating their advices from theoretical insights that can be derived from – or extended to – the academic literature in business management. As such, the practitioner's literature focuses on the formulation of policies of environmental management and on their efficient implementation by highlighting successful cases of best practice (e.g. Fussler and James, 1996; Hart, 1997; Romm, 1999; Holme and Watts, 2000; Holliday *et al.*, 2002). A wide range of practical tools, techniques and tactics for engaging with environmental issues are described and suggested in a vast number of books or professional manuals about corporate environmental management (e.g. Piasecki, Fletcher and Mendelson, 1999; Madu, 2000; Lesourd, 2001; Sheldon and Yoxon, 2002; Schaltegger, Burritt and Petersen, 2003).

During the Nineties, researchers increasingly attempted to apply theories grounded in their own disciplinary traditions to study environmental-related issues. A field of academic research gradually emerged, comprising scholars interested in environment-related aspects in management that has been labelled "corporate greening", "corporate environmentalism", or "sustainable management" (cf. Schot and Fisher, 1993; Collins and Starik, 1995; Starik and Rands, 1995; Hoffman and Ehrenfield, 1998; Starik and Marcus, 2000; Sharma, 2002). As discussed in Hoffman (2001) the definition of corporate environmental practices has been greatly contested over the past four decades and represents a high degree of field-level conflict and change. The debate is linked with the definition of the role of corporation in modern capitalistic societies, a topic that has attracted much attention in recent years in connection to economic globalization processes. The opinion of Milton Friedman (1970), claiming that "*the social responsibility of business is to increase its profits*", laid the foundation for a controversy that is still lively nowadays. Friedman's clearly stated that (1970):

> "*Expenditures on reducing pollution beyond the amount that is in the best interests of the corporation or that is required by law in order to contribute to the social objective of improving the environment …[is] pure and unadulterated socialism…There is one and only social responsibility of business: to use its resources and engage in activities designed to increase its profits so long as it stays within the rules of the game, which is to say, engages in open and free competition without deception or fraud*".

The institutional and cultural context has profoundly changed since Friedman's point of view was published (cf. Bazerman, Messick, Tenbrunsel and Wade-Benzoni, 1997; Bazerman and Hoffman, 1999). At present times, it is widely recognized that managers cannot disconnect business concerns from the institutional legitimacy that surrounds decisions inherent to capital acquisition, operational efficiency and market reputation. It is currently evident that institutional definitions of environmental protection have moved out from the realm of socially responsible management or mere regulatory compliance to environmental laws and have entered the realm of strategic business management (e.g. Berry and Rondinelli, 1998; Banerjee, 2002b; Bansal, 2002; Marcus, 2004).

Academic research

Special issues about environmental management as a field of scholarly research have been published in mainstream management journals like *Academy of Management Review,* [vol. 20(4) 1995] and *Academy of Management Journal* [vol. 43(4) 2000]. In the area of operations management, two special issues dedicated to environmental management as research topic are available in *International Journal of Operations and Production Management* [vol. 20(2) 2000] and in *Production and Operations Management* [vol. 10(3) 2001]. These special issues have the important role of signalling the relevance of environment-related issues in traditional management research. They also provide the opportunity to the special issues' editors to discuss what has been researched and highlight further directions of research. Recent monographic studies collecting academic research about corporate sustainability and environmental management summarize recent advances in the area (Bazerman *et al.*, 1997; Coglianese and Nash, 2001; Hoffman and Ventresca, 2002; Sharma and Starik, 2002; Sharma, 2004). Despite the growing amount of academic publication in this research area, Dobers, Strannegård and Wolff (2001:336) noted that:

> *"Yet, there have been no explicit attempts to classify and categorize the research within the field, its theoretical base and the knowledge interests underpinning the field"*.

The difficulty of organizing the literature in environmental management is related to the fact that academic disciplines involved in the study of the relationships between the natural environment and (business) organizations are extremely diversified. The topic of corporate environmentalism or sustainability appears as a highly dynamic research context, yet it does not constitute an established academic field. Different disciplines or sub-specialties in social sciences (such as economics, sociology, psychology, law and ethics) explore corporate environmental issues from a different theoretical perspective, in their own specialty terminology, often asking similar questions about the same phenomenon and offering specific implications in their respective fields. Fragmentation in academic research as a result of the multi-disciplinary areas involved is thus a typical feature of the "greening" literature (Gladwin, 1993), though the same concern has been recently advanced in management accounting research as well (cf. Covaleski *et al.*, 2003; Merchant *et al.*, 2003).

Among recent contributions, Schot and Fisher (1993), Hoffman (1997), Starik and Marcus (2000) and Andrews (2001) outlined the stages of corporate "greening" as a research discipline and its development in subsequent historical contexts. Of particular importance to understand this area of research is the definition of the meaning of "greening", which has attracted the interest of academics in the past two decades. Among the early attempts to discuss "greening" by researchers in organizational theory, Gladwin (1993) points out that this concept appears to be multidimensional and nothing but a powerful metaphor. Further Rasanen, Merilaninen and Lovio (1995) emphasize that "greening" is a new catch-phrase, covering a diverse set of organizational activities. As noted more recently by Forbes and Jermier (2002), "greening" is conceptualized as a *process* and imply that organizations vary in the degree to which they emphasize different components of "greening". Apart from these vague definitional attempts around "greening", a key question remains: *Is there such a thing as environmental management? If so, what does it consist of, and how should researchers define environmental performance as its immediate output?* To address these questions, there has been a proliferation of classifications and theoretical models of environmental management approaches that originated from practitioners' or academic studies. I will draw upon the overview by Kolk and Mauser (2002) about these models to briefly discuss recent developments about the constructs of environmental management and environmental performance that are particularly relevant for the empirical part of the dissertation.

According to the overview by Kolk and Mauser (2002), the mid-Nineties witnessed the publication of a large number of stage models or typologies[1], mostly having a normative tone to serve as management tools for managers, consultants and policy makers. These early classifications of environmental management attempted to describe or prescribe organizational postures towards environmental management along a linear continuum. In brief, the early conceptual models specified developmental stages through which organizations can progress, and typically emphasized the contrast between relatively superficial corporate environmentalism in comparison with more encompassing and pro-active approaches. For instance, Hunt and Auster's (1990) early classic framework specified a five-stage classification of *environmental strategy*; in their model, firms can be placed along a continuum ranging from organizations that address environmental considerations with "band aid solution" (*beginners*) to organizations that implement fully integrative environmental management systems (*proactivist*). A similar approach was suggested in Roome's (1992) model of environmental strategy that contrasted *compliance-oriented* with *compliance–plus* (or *leading-edge*) organizations, with the latter implementing both cleaner technologies and more environmentally-friendly practices in their organizational structure and culture. After reviewing the typologies proposed by the literature, Kolk and Mauser (2002) pointed out that extreme diversity characterized these models in terms of number of ideal stages, defining criteria and empirical operationalization. They addressed the limitations of these conceptualized models by emphasizing that (Kolk and Mauser, 2002:25):

> *"The goal of environmental management models is generally broad and conceptual, which is also their main contribution. As a result, however, they have limited suitability for specific situations, and insufficiently reckon with organizational and strategic complexities. Moreover, what seems to be the models' main underlying deficiency is that operationalization is difficult because of their focus on environmental management rather than environmental performance… In addition, there is a theoretical justification for separating outcomes from policies and measures, while recognizing the close link between the two types of indicators".*

Concerning the operationalization of the environmental management models, increasing attention has been devoted to the definition of instruments aiming at empirically classifying environmental management practices or principles. In Table A.1 in Appendix A, I summarized a non-exhaustive list of representative examples of scholarly research containing instruments aiming to capture environmental management dimensions. Most studies indicate that prior stage models of environmental management remain quite popular, and among them the model by Hunt and Auster (1990) and Roome (1992) are mostly used. Several instruments attempted to measure the position of a company along a continuum by referring to selected principles or practices about environmental management. It is remarkable the variety of labels used to define the construct of interest, which still suffers from semantic ambiguity. Examples of alternative labels proposed in the managerial literature are the following (presented here in chronological order): *environmental program* (Vastag, Kerekes and Rondinelli, 1996), *environmental issues integration* (Judge and Douglas, 1998), *environmental strategy* (Sharma and Vredenburg, 1998), *environmental practices* (Aragon-Correa, 1998), *environmental ambition* (Klassen and Angel, 1998), *environmental commitment* (Roy, Boiral and Lagace, 2001), *corporate environmentalism* (Banerjee, 2002a; Banerjee, Iyer and Kashyap, 2003), *environmental management system* (Melnyk *et al.*, 2003). Some researchers identify "greening" with the set of environmental management practices at the operational level of analysis. For instance, in the operations management literature *environmental operations management* is defined at the plant level as the *integration of environment principles with the decision making process for the conversion of resources into usable products* (Angell and Klassen, 1999:576). Within this literature, *eco-manufacturing strategy* (Newman and Hanna, 1996), *environmentally friendly practices* (Handfield, Walton, Seeger and Melnyk, 1997) and *environmental management orientation* (Klassen and Whybark, 1999a) also have been used to denote environmental management initiatives. On the contrary, Banerjee (2002a:181) defined and operationalized *corporate environmentalism* at the organizational level as:

> *"the organization-wide recognition of the legitimacy and importance of the biophysical environment in the formulation of organizational strategy, and the integration of environmental issues into the strategic planning process."*

As a general remark that reflects the developments of the literature, it is evident that researchers increasingly put attention to the psychometric properties of the constructs under investigation in the attempt to enhance reliability and validity of their instruments. Nonetheless, lack of replication studies and homogenous scales has impeded so far to devise common and valid instruments to conceptually define and empirically assess environmental management. As a result, what constitutes environmental management differs among studies and academic fields. This disagreement indicates a lack of maturity of the field, which has not yet laid down solid conceptual and empirical foundations.

A similar trend in academic research can be foreseen between the early developments of the literature in *quality management* and the recent developments in the environmental management literature. According to recent reviews, only after almost two decades quality management has currently entered a mature phase in terms of having established sound definitional foundations (cf. Cua, McKone and Schroeder, 2001; Sousa, 2001; Sousa and Voss, 2002). Many companies have embedded quality management practices into their normal operations and these practices are being stripped of their faddish connotations, to the point that nowadays it is generally accepted that the variable *quality management* exhibits satisfactory convergent and discriminant validity (Hackman and Wageman, 1995).[2] In fact, a series of studies are currently available that have operationalized the construct of quality management, particularly in operations management literature (e.g. Saraph, Benson and Schroeder, 1989; Ahire, Golhar and Waller, 1996; Black and Porter, 1996; Subba Rao, Solis and Ranghunatan, 1999; Cua *et al.*, 2001; and Sousa and Voss, 2002 for a review). In comparison with the quality management literature, researchers in environmental management have not yet yielded solid foundations for the field given the analogy that can be drawn between quality and environmental management. Underlying both these initiatives is a philosophy of organizations as streamlined processes that link inputs and outputs following a “process management” approach (e.g. Benner and Tushman, 2003). Observed parallels between quality management and environmental systems were examined and discussed by several researchers in operations management (among others Klassen and McLaughlin, 1993; Willig, 1994; Bloemhof-Ruwaard, Beek, Hordijk and van Wassenhove, 1995; Gupta, 1995; Sarkis and Rashid, 1995; Gupta and Sharma, 1996; Kitazawa and Sarkis, 2000; ReVelle, 2000; Sroufe, Curkovic, Montabon and Melnyk, 2000; Curkovic and Landeros, 2001; Corbett and Pan, 2002). These studies point out that quality management and environmental management managerial philosophies and holistic approaches share the following characteristics: 1) they aim to improve a company’s final output; 2) they emphasize long-range planning over short-term considerations; 3) they involve changing relationships between companies and their employees, suppliers, and customers; 4) they strive for a cultural change; 5) they stress improved information, communication, training and accountability; 6) they demand continual improvement (Curkovic and Landeros, 2001). Environmental management systems are viewed as being quality management systems extended and modified to deal with environmental issues. The most relevant example in this direction is given by the international standard ISO 14001 for environmental management systems (EMS). For instance, the “no waste” goal of environmental management closely parallels the quality management goal of “zero defects”. Quality management focuses on waste as it applies to process inefficiencies, whereas environmental management tends to focus on physical outputs such as solid and hazardous waste. Because the two managerial concepts share a similar focus, researchers note that it makes sense to use many of the tools, methods, and practices of quality management in implementing an environmental management system (Klassen and McLaughlin, 1993; Hart, 1995; Epstein, 1996; Berry and Rondinelli, 1998). Similar to ISO 9000, the ISO 14001 EMS requirements embody the PDCA (plan-do-check-act-)

cycle. In the PDCA cycle, an organization plans a change aimed at improvement (plan), implements the change (do), evaluates the results (check) and finally institutionalizes the change (act). For an organization that is committed to implementing or maintaining a continuous source reduction program, some important elements of ISO 14001 include (Cascio, Woodside and Mitchell, 1996; Tibor and Feldman, 1996):

- Identifying environmental aspects and impacts through a structured process;
- Establishing objectives and measurable goals;
- Defining roles and responsibilities;
- Enhancing awareness and competency among employees by continuous training;
- Completing corrective actions through a structured process; and
- Reviewing EMS by senior management through a structured process.

Environmental performance measures

To meet increased demand for environmental performance information, regulatory agencies, environmental groups, international agencies and corporations themselves have developed more sophisticated inventories of performance measures to capture various elements of environmental performance as element of wider corporate social performance (Ilinitch, Soderstrom and Thomas, 1998; Kolk and Mauser, 2002). Recent attempts have been made to encourage standardization in the definition and measurement of environmental performance at different levels (cf. Andersen and Fagerhaug, 1999; Bennett and James, 1999). For instance, sustainability indicators have been elaborated at national level and periodic reports are available at country level from the Organisation for the Economic Co-operation and Development (OECD, 2004). At the sector level, several initiatives have been taken to streamline the measurement and reporting of environmental measures, particularly in sectors more exposed to environmental risks and public scrutiny. As an example, the National Academy of Engineering completed a comprehensive analysis of environmental performance metrics currently used by four major US manufacturing industries (chemical, electronics, automotive, and pulp and paper) (NAE, 1999). In the chemical sector, recent recommendations on environmental indicators were issued by the Association of the Dutch Chemical Industry (VNCI, 2001) and by the Institution of Chemical Engineers (Icheme, 2002). As with the firm level of analysis, there has been a growing literature that proposed various approaches to the measurement of environmental performance (cf. Tyteca, 1996; Bennett and James, 1998a; Callens and Tyteca, 1999; Tyteca, 1999; Olsthoorn, Tyteca, Wehrmeyer and Wagner, 2001; Tyteca, Carlens, Berkhout, Hertin, Wehrmeyer and Wagner, 2002 for recent and exhaustive reviews on this issue). The most common approach in operationalizing environmental performance has been through aggregation of a set of indicators and checklists gathered at facility level. Indicators are selected largely because comparable data are available from public pollutant release and transfer registries (PRTRs). Most databases are available in United States, such as the EPA’s Toxic Release Inventory (TRI), which applies to a wide array of industries and consists of a panel of thousands of facilities reporting annual data since 1987. Similarly, Australia, Canada, Korea, the Slovak republic and the European Union also operate PRTRs and publicly disseminate collected data at the facility level. In addition, specialized companies in the financial sector have devised an increased number of sustainability ranking systems. Among them, particularly in empirical research carried out in North America, the most diffused databases are the Investor Responsibility Research Center (IRRC) and the Council for Economic Priorities (CEP). As demonstrated by Ilinitch, Soderstrom and Thomas (1998), methodological inconsistencies among measures and ratings inhibit stakeholders' ability to interpret such data and make objective comparisons across time. The available databases have also been criticized because the performance indicators they contain are neither tailored to nor reflective of the issues faced by the individual company or industry. Moreover, they tend to reflect historical performance that is both incomplete and not integrated into a wider measurement of shareholder value or financial risk. Finally, the lack of public databases outside the United States does not allow for replication of studies from companies in other areas of the world. On this topic, Gerde and Logdson (2001) examined the available databases that measure US corporate environmental performance and indicate recent trends that should improve quantity and reliability of data. The main concern is that there is no clear relationship between available data and corporate environmental performance as a construct. More recently, Toffel and Marshall (2004) evaluated several weighting methods used to assess chemical release inventories and provide an up-to-date review of the existing approaches that could be used in empirical research. Among the most recent efforts to favour standardization, two initiatives are noteworthy in terms of potential impact on the business community for (1) the comprehensive approach that they proposed, and (2) the attempt to link measurement and reporting of environmental performance measures into financial accounting standards. The first one refers to the guidelines elaborated by the Global Reporting Initiative[3] (GRI, 2002). These guidelines are for voluntary use by organizations for reporting on the economic, environmental, and social dimensions of their activities, products, and services. So far, this initiative appears to be the most diffused approach to report a company's Triple Bottom Line. As to December 2004, 615 organizations voluntarily adhered to the use of GRI guidelines for their corporate reports. The second guideline is more specifically focused on the definition, measurement and disclosures of environmental information drawing directly from International Financial Reporting Standards (UNCTAD/ISAR, 2002).

Concluding remarks

The above discussion allows the following broad considerations about the current state-of-the-art of research in environmental management. First, environmental management as area of investigation is a novel one and empirical research is limited. Second, a normative approach in researching environmental management is still predominant. Sustainability management remains a research context with weaknesses in terms of theoretical explanation and contribution to extant theories from core disciplines. Most of the literature available consists of professional studies or popular articles, discussing surveys of practice or case studies in which the application of successful managerial systems in the area of environmental management is either described or prescribed. Third, extreme variation is found in the definition of the object/phenomenon of study and in the way the variables concerning the phenomenon are operationalized. This applies particularly to the concept of environmental performance, which is per definition multi-dimensional and reflects continuous updates due to advances in scientific knowledge and measurement technology (cf. on this aspect the discussion in Section 6.5.1). Fourth, the analogies between quality management and environmental management are apparent in many respects. The academic field of environmental management is expected to follow the same pace of development that occurred in the last two decades in the field of quality management.

In the rest of the dissertation, I will refer to “environmental management” and not to “greening” as a comprehensive label denoting organizational initiatives in the area of corporate environmental management and sustainability. In the empirical part of the dissertation, I will attempt to overcome the limitations of extant literature by drawing upon instruments developed from prior research whenever possible. In absence of them, I will try and provide evidence of reliability and validity of the constructs relying upon an exploratory approach (refer to Chapter 4).

2.2.2 Environmental accounting: the research area and the literature

Developments of the field

Historically, social accounting can be considered as the precursor field of environmental accounting. In a review of social accounting literature, Mathews (1997) noted a number of definitions of the field of social and environmental accounting. He concluded that definitions appear to be problematic because of the debate about voluntary or mandatory disclosure, and the quantitative versus qualitative dimensions of information. Similarly, Gray (2002:687) concurs that social accounting takes a wide variety of forms and appears under various labels (i.e. *social responsibility accounting, social audits, corporate social reporting, employee and employment reporting,* and *environmental accounting and reporting*), that cover all forms of “*accounts which go beyond the economic*”. According to Gray, Owen and Maunders (1987:ix) social and environmental accounting (SEA) should be seen as:

> *“…the process of communicating the social and environmental effects of organizations’ economic actions to particular interest groups within society and to society at large. As such it involves extending the accountability of organizations (particularly companies), beyond the traditional role of providing a financial account to the owners of capital, in particular, shareholders. Such an extension is predicated upon the assumption that companies do have wider responsibilities than simply to make money for their shareholders…. More specifically, social*

> *accounting is about some combination of: (a) accounting for different things (i.e. other than accounting strictly for economic events); (b) accounting in different media (i.e. other than accounting in strictly financial terms); or (c) accounting to different individuals or groups (i.e. not necessarily only accounting to the providers of finance); and (d), accounting for different purposes (i.e. not necessarily accounting to enable the making of decisions whose success would be judged in financial or even only cash flow terms)".*

The early developments of SEA can be traced back to the mid- to late Sixties. It is not the aim here to provide an analysis of the historical diffusion of SEA. In this respect, Gray (2002), Epstein (2003) and Owen (2003) summarized the developments in the SEA literature, while a more detailed historical excursion in the area of environmental accounting alone is recently provided by Hibbitt (2004). The initial development of SEA has been very promising, both in practice and in academic literature. Examples of early methods and applications of this field are available from seminal descriptive studies published in the first issues of *Accounting, Organizations and Society* during the mid-Seventies (e.g. Epstein, Flamholtz and McDonnough, 1976; Ullmann, 1976; Dierkes and Antal, 1977; Grojer and Stark, 1977). However, in the Eighties, the situation seemed to change dramatically. SEA lost momentum because governments and business became increasingly focused on issues related to economic prosperity while issues of social and environmental concern were judged of secondary importance (cf. Owen, 1992). Referring to this stage of SEA, Epstein and Birchard state that (2001:139):

> *"[Social and environmental accounting] failed because it was never institutionalized in organizations. Companies never made it a part of strategy making, costing, capital budgeting, and performance evaluations. In short, managers never used the methodology in day-to-day decisions".*

The renewed interest about SEA since the early Nineties is associated with the recent outgrowth of initiatives that relate to the diffusion of environmental management systems and the debate over corporate social responsibility. Environmental issues have steadily re-gained relevance in different areas of accounting practice. In recent years, the most remarkable signal of renewal of interest refers to the diffusion of corporate environmental reporting (cf. KPMG/WIMM, 1999; Gray and Bebbington, 2001; Kolk *et al.*, 2001; KPMG/UvA, 2002; PriceWaterhouseCoopers, 2002; Kolk, 2003, 2004; PriceWaterhouseCoopers, 2004b; Trucost plc and Environmental Agency, 2004). Among the latest terms created to address these issues is the, so-called, *Triple Bottom Line* popularized by the consultant John Elkington (1997), as a conceptualization of the need for businesses to deliver simultaneously economic prosperity, environmental quality and social equity (refer to Adams, Frost and Webber, 2004 for a review of the literature about Triple Bottom Line). Recent developments concern also the verification and the provision of assurance services applied to companies' environmental reports (e.g. Beets and Souther, 1999; Collison and Slomp, 2000; Wallage, 2000; CPA Australia, 2004; Dixon, Mousa and Woodhead, 2004; FEE, 2004; Owen and O'Dwyer, 2004; Yakhou and Dorweiler, 2004; Zadek and Raynard, 2004). To sum up, the historical development of environmental accounting can be outlined as follows (cf. Mathews, 1997):

- 1970s: initial phase with normative models of conduct;
- 1981-1990: debate on the role of accounting in disclosing information on environmental activities;
- 1991-1995: maturing of environmental accounting, in providing environmental disclosures and in launching environmental auditing;
- Current: the role of environmental accounting is viewed as measuring environmental performance exceeding regulatory standards. It can be associated to a wider debate concerning the societal role of corporations. Labels like *Triple Bottom Line* and sustainable reporting capture recent developments in the field.

Renewed interest towards SEA is also signalled by the increased availability of (chapters of) textbooks dedicated to the topic of environmental accounting (Ansari *et al.*, 1997; Schaltegger and Burritt, 2000) or the creation of specialized academic courses in this area (cf. Sefcik, Soderstrom and Stinson, 1997; Grinnell and Hunt, 2000; Rheinlander and Kramer, 2003; Holland, 2004). From a business perspective, interest has steadily grown with the aim of developing a better understanding of environment-related financial costs and benefits as an input to conventional (management) accounting practices (cf. Schaltegger and Burritt, 2000; Burritt, Hahn and Schaltegger, 2002; Jasch, 2003; Burritt, 2004). As anticipated in the first Chapter, this interest triggered the emergence of a new field in the mid-Nineties labelled "environmental management accounting" (EMA), defined by Bennett and James (1998b:33) as:

> *"the generation, analysis and use of financial and related non-financial information in order to integrate corporate environmental and economic policies and build a sustainable business".*

The International Federation of Accountants refers to EMA as (IFAC, 1998:3; 2004):

> *"the management of environmental and economic performance through the development and implementation of appropriate environment-related accounting systems and practices. While this may include reporting and auditing in some companies, environmental management accounting typically involves life-cycle costing, full cost accounting, benefits assessment, and strategic planning for environmental management".*

Further, the initiative launched by the United Nations to disseminate environmental accounting practices states that (United Nations, 2001):

> *"EMA serves as a mechanism to identify and measure the full spectrum of environmental costs of current production processes and the economic benefits of pollution prevention or cleaner processes, and to integrate these costs and benefits into day-to-day business decision-making".*

The diffusion of EMA appears to be actively sponsored by national accounting professional institutions (e.g. IFAC, 1998; CIMA, 2002; ICAA, 2003; ACCA, 2004; IFAC, 2004) and by international initiatives supported by the United Nations (United Nations, 2000, 2001). The United States was the first country to establish a formal public program to investigate and promote EMA in collaboration with the Environmental Protection Agency (US EPA) (EPA, 1995). Moreover, there has been a recent, strong upswing in interest and activities around EMA in a number of other countries. Among them, the US EPA program has been taken over in 2002 by an international initiative with the mission of promoting the integration of environmental cost information and materials & energy flow information into routine management decision-making of private and public sector organizations. The initiative is labelled as EMAN (Environmental Management Research Network) and comprises a network of researchers, consultants, business representatives and policy advisors interested in EMA as a business management tool[4]. In Europe, EMAN-Europe originally developed from the “Ecomac” (Eco-Management as a Tool of Environmental Management) research project which was carried out for the European Union’s Environment and Climate Programme (cf. Bartolomeo *et al.*, 2000). Since its formation in 1997 EMAN-Europe has developed its own website and periodic newsletters to members, has sponsored annual conferences with financial support from the European Union and has published proceedings from these conferences on recent developments in the area with a predominantly practitioner’s approach (Bartolomeo, Bennett, Bouma, Heydkamp, James, de Walle and Wolters, 1999; Bennett, Bouma and Wolters, 2002b; Bennett, Rikhardsson and Schaltegger, 2003).

Regarding the contents of the practitioner’s literature, EMA mainly refers to the application in the environmental area of techniques in cost management and cost accounting. For instance, an environmental cost accounting system can be designed as a specific application of Activity-based costing, which focuses on environmental-related activities as key cost drivers (e.g. Ansari *et al.*, 1997; Pojasek, 1998; Quarles and Stratton, 1998). Capital budgeting and valuation techniques have also been adapted to evaluate “green” investments (Tellus Institute, 1995; Epstein and Roy, 1997; NEWMOA, 1998; McDaniel, 2000; Reed, 2001; ESCTP, 2004). Life cycle costing is another area of recent developments, though the emphasis on end-of-life costs reflects the growing emphasis on product-life costing in management accounting in general (e.g. Epstein and Roy, 1997; NDCEE, 1999; Dunk, 2004). Thus, it can be argued that the same management accounting techniques available for traditional business operations could be adapted to satisfy the generation and use of information for environment-related purpose. Several case studies of best practice implementation have been described in practitioners’ literature, showing the benefit of controlling for environmental costs through appropriate management actions (see Tuppen, 1996; Shields, Beloff and Heller, 1997; Bennett and James, 1998a, 1998c; EPA, 1998; Tellus Institute, 1998; Rogers and Kristof, 2003). In the United States, forty-five case studies documenting the benefits of environmental accounting have been carried out under the Environmental Accounting Project sponsored by the Environmental Protection Agency (Ditz *et al.*, 1995). Similarly, Epstein (1996) provided insights into current diffusion of EMA in thirty US companies through a survey of practice sponsored by the Institute of Management Accountants. More recently, Frost and Wilmhurst (2000) and Parker (2000a; 2000b) document the diffusion of EMA in Australia. A survey of practice carried out in Europe under the "Ecomac" project (cf. before) has investigated the implementation of eco-management accounting in eighty-four companies in four European countries (Bartolomeo *et al.*, 2000). The survey highlighted a moderate but growing interest in EMA practices, though with international differences and despite internal barriers to their implementation. With regards to the diffusion of EMA practices, the researchers concluded that (Bartolomeo *et al.*, 2000:39):

> *"… for most companies, environmental management accounting will be an intermittent process in which periods of low-level, low-profile, activity are punctuated by bursts of considerable attention and innovation. These will often be triggered by changes such as the introduction of new internal accounting systems. … Although many companies claim some environmental management accounting activity, this often represents only a few isolated experimental projects rather than a systematic and comprehensive implementation"*.

Recent applications of EMA in the field of performance measurement and control focus on adaptations of the balanced scorecard (e.g. Johnson, 1998; Epstein and Roy, 2001; Epstein and Wisner, 2001; Brignall, 2002; Figge *et al.*, 2002; Zingales, O'Rourke and Hockerts, 2002; Bieker, 2003; Kaplan and Norton, 2003). Proponents of a, so-called, "sustainable balanced scorecard" argue about the importance to translate an environmental strategy into measures of performance that reflect, for instance, the objective to reduce the use of materials, to lower the proportion of waste, or to encourage environmentally benign process and product design. In essence, they argue that a balanced scorecard is a useful tool for promoting awareness both of the financially induced and of the physical aspects of environmental management. At this point, no agreement exists on the appropriate set of environmentally induced financial measures and related financial indicators to include in a balanced scorecard (Schaltegger and Burritt, 2000:155). It might be expected that similar industries would tend to implement similar scorecards. However, in practice, diverse measures are being used even by similar organizations (cf. further the evidence from the case study in Chapter 6).

Academic research

As far as academic research is concerned, environmental accounting research has emerged over the last twenty years as a distinct thread of research within the broader area of social accounting. Scholarly research in environmental accounting appears to be highly fragmented in approaching and studying phenomena that relate to sustainability and environmental management. The variety of research carried out in the field of environmental accounting is clearly reflected in the different research traditions of the academic journals published in the accounting area. Special issues in academic journals which dedicated entire volumes about the state-of-the-art research in the area of social and environmental accounting have been the following: *Accounting, Auditing & Accountability Journal* [vol. 4(3) 1991, vol. 10(4) 1997, vol. 15(3) 2002], *Accounting Forum* [vol. 19(2-3) 1995, vol. 24(1) 2000 and vol. 28(1) 2004], *Accounting, Organizations and Society* [vol. 17(5) 1992], the *Asia-Pacific Journal of Accounting* [vol. 4(2) 1997], the *Journal of Accounting and Public Policy* [vol. 16(2) 1997] and the *European Accounting Review* [vol. 9(1) 2000]. Further, *Advances in Environmental Accounting and Management* (Freedman and Jaggi, 2000, 2003) offers a new monographic series of academic contributions in the area at the interface between environmental management and accounting. Finally, the bi-annual newsletter *Social and Environmental Accounting*, published by the Center for Social and Environmental Accounting at the University of Saint Andrews, provides short reviews of academic articles and books in the area, and updates about academic events inherent to social and environmental accounting.

Following the classification advanced by Brown and Fraser (2004) and Mathews (2004), a distinction in the environmental accounting literature can be drawn among three broad research traditions labelled respectively under the banners of the "*business case*", the "*stakeholder accountability*" and the "*critical school*" approach (Table 1.1 in Smith, 2003:5 for a classification and discussion over accounting research traditions). Table 2.1 summarizes the main differences between the three literatures along key dimensions or criteria.

The *"business case"* banner is the term used to describe a tradition in SEA research which is embedded into mainstream research in accounting and finance (an alternative label is "managerialist" research, cf. Gray, 2002). This tradition of research applies quantitative research methods impinging on a positivist/functionalist approach (Smith, 2003). The research agenda is characterized by a drive to examine SEA to understand whether it can enhance profitability. Consequently, SEA is not necessarily seen to satisfy the information needs of wider stakeholder groups or because management accepts some moral imperative to change the way in which business operates (Mathews, 2004:36). Business case proponents view SEA initiatives primarily from the perspective of corporations and their shareholders. Hence, SEA field is considered as an extension of management's existing toolkit for enhancing compliance, operational efficiency, reputation and ultimately shareholders' value. Rather than seeing SEA as a trade-off against profits, business case proponents promote the idea of corporations managing their social environment as part of their core business activity. Factoring social considerations into business decisions and playing a leadership role on social issues is also viewed as a way of promoting a "light-handed" approach to regulation. Think-thanks financed by the private sector such as the World Business Council for Sustainable Development

(WBCSD) and Business in the Community (BITC) have helped to spread and reiterate the message internationally that SEA practices are beneficial for the business.

Table 2.1 – Traditions of research in social and environmental accounting (SEA) (adapted from Ryan *et al.*, 2002, Smith, 2003, Brown and Fraser, 2004, Hibbitt, 2004 and Mathews, 2004)

Traditions of research / ***Criteria***	**"Business case"**	**"Stakeholder accountability"**	**"Critical school"**
Research approach	Positivist/Applied	Interpretative	Critical/Normative
Research methodology	Quasi-experimental design based on hypothetical-deductive verificationism; quantitative data analysis	Multiple methods mostly relying upon inductive approach to establish views about phenomena, including case studies, ethnography, hermeneutics and phenomenology; qualitative data analysis	
Disciplines of reference	Economics, Financial economics, Financial accounting	Organizational theories	Sociology, Political Economy, Philosophy
Research purpose	SEA is viewed as an extension of management's existing toolkit for enhancing corporations' shareholder value	SEA should increase accountability of organizations towards all stakeholders (*wide* view of accountability) or towards influential stakeholders (*narrow* view of accountability)	SEA should expose the basic contradictions and exploitative aspects (environmental degradation and social inequalities of the capitalist system)
Key-words	Eco-efficiency, Triple Bottom Line, Sustainable added value	Legitimacy, Accountability, Transparency	Eco- and Social-justice, Sustainability
Key assumptions	Shareholder primacy is assumed above all other stakeholders	Shareholder primacy is not assumed. Stakeholders have "information rights" which must be acknowledged for decision-making purposes	Skeptical position about the potential for "real accountability" in the absence of radical change capitalist system
Role of regulation	It generally favors a "voluntary" approach towards SEA adoption	Regulation is necessary to ensure balanced reporting for accountability, monitoring and decision-making purposes. Otherwise, the risk of "greenwash" is too high	Regulation is important in securing information rights. However, need to be wary of opportunities elites have to appropriate regulatory processes (i.e. through agenda-setting)

Table 2.1 (continued)

Traditions of research / *Criteria*	**"Business case"**	**"Stakeholder accountability"**	**"Critical school"**
Role of stakeholders	SEA involves "consulting" with stakeholders	Stakeholders must "meaningfully participate" in organizational decisions and corporate reporting practices	"Meaningful stakeholders' engagement" is unlikely within current accounting practices and governance structures
Contribution to practice	SEA requires more focus on "technical activities" such as the development of environmental accounting standards, environmental performance measures and control systems	Operationalization of SEA is inevitably political. Intervention by regulatory bodies through stakeholder participation is required to develop meaningful accountability measures	Current economic system and accounting practices require radical change. Dominance of capital oriented values means SEA is likely to fall victim to business capture.

In particular, this strand of research has closely investigated the question whether investing in environmental protection has a positive effect on firms' bottom line, with large part of the empirical studies focused on the relationship between environmental/social performance and financial performance (see further Section 2.2.7).

Another strain of studies referring to a "*stakeholder-accountability*" approach focuses on *organizational legitimacy* as an underlying driver for SEA, particularly when examining the determinants of social and environmental disclosures. Dowling and Pfeffer (1975:122) have been widely cited with the following definition of organizational legitimacy:

> *"Organizations seek to establish congruence between the social values associated with or implied by their activities and the norms of acceptable behavior in the larger social system of which they are a part. Insofar as these two value systems are congruent we can speak of organizational legitimacy. When an actual or potential disparity exists between the two value systems, there will exist a threat to organizational legitimacy".*

Stakeholder-accountability theorists view large corporations as quasi public institutions and seek to promote a more transparent and democratic society (cf. Gray, Owen and Adams, 1996). Accounting helps make things account-*able* and provides an important mechanism of social control. In this vein, responsiveness to the multiplicity of stakeholders (*wide* notion of accountability in Mathews, 2004) or to some influential stakeholders' groups (*narrow* notion of accountability) requires a form of plural accountability. Groups such as employees, consumers, local communities and Non-Governmental Organizations have a "right to know" and can apply "exit", "voice" or "loyalty" options (Hirschmann, 1970) as reaction to corporate behavior. Given the pluralist nature of the relationships involved, it cannot be assumed that all groups will agree on what the relevant dimensions of performance are and considerable potential conflict might arise. Researchers belonging to this research tradition are thus more concerned about the society's impact on business than business' impact on society (O'Dwyer, 2003:527). Stakeholders-accountability proponents argue that under the business-case approach SEA is "business as usual" and stakeholder-management occurs to serve the purposes of the business agenda. They concur that the business case approach leads at best to (Owen, Swift and Hunt, 2001:275):

> *"…a 'soft' form of accountability, whereby organizations engage in stakeholder dialogue for the purpose of voluntary self-reporting on their trustworthiness as part of a reputation building process".*

For this stream of research, greater access to SEA information is viewed as an essential part of increasing transparency surrounding corporate activity and its consequences for stakeholders (e.g. Adams, 2004; O'Dwyer, 2004). In turn, regulation is usually supported on the basis that it secures information rights for stakeholders and informed participation. To sum up, the strand of research under the banner of *"stakeholder-accountability"* is largely dismissive of the managerialist agenda set by the *"business case"* proponents for SEA. In comparison with the business case approach, the focus in this area is most notably on developing democratic approaches to corporate governance, more participatory political culture and *real* accountability mechanisms through SEA practices.

The third and final body of literature comprises the, so-called, "*critical school*" of SEA which is rooted in the critical perspective of accounting research. Critical theorists' main argument is that real accountability of corporations is not achievable in absence of radical change in a capitalist society. Global capitalism has led to a narrowing of democratic debate and the rolling back of the State, promoting a "democracy of elites" (cf. Lehman, 2002). While communitarian approaches to accountability may be an advance over narrow liberal models, there is still the difficulty that communities may simply reflect and reproduce the power imbalances that are part of current systems. According to this view, voluntary SEA initiatives are most realistically viewed as forms of disinformation ("greenwash", cf. Section 3.2.1) that result in the "appropriation" of sustainable development agenda by business interests. For instance, commenting upon the discourse led by groups such as the WBCSD, Springett (2003:74) argued that:

> *"[This] eco-modernist paradigm comfortably appropriates aspects of the shift to sustainable development – those that concern business risk and 'eco-efficient' use of resources that cut business costs – deflecting demands for more radical change and subsuming into the traditional business model the rhetoric of greener business as usual…".*

Despite considering SEA at best as ideological weapons, critical theorists still believe that SEA can be used to promote counter-hegemonies aimed at transforming the status-quo in the form of adversarial accounting and externally prepared "anti-reports" (e.g. Tinker, Neimark and Lehman, 1991). In the past decade, Mathews (1997), Gray and Bebbington (2000) and Gray (2002) provide, among others, a synthesis of the literature available in this area. Recent articles published in the journal most representative of the critical school tradition (*Critical Perspectives in Accounting*) offer a more updated account of the debate from this stream of research (e.g. Bebbington and Gray, 2001; Lehman, 2001; Gray and Collison, 2002).

Concluding remarks

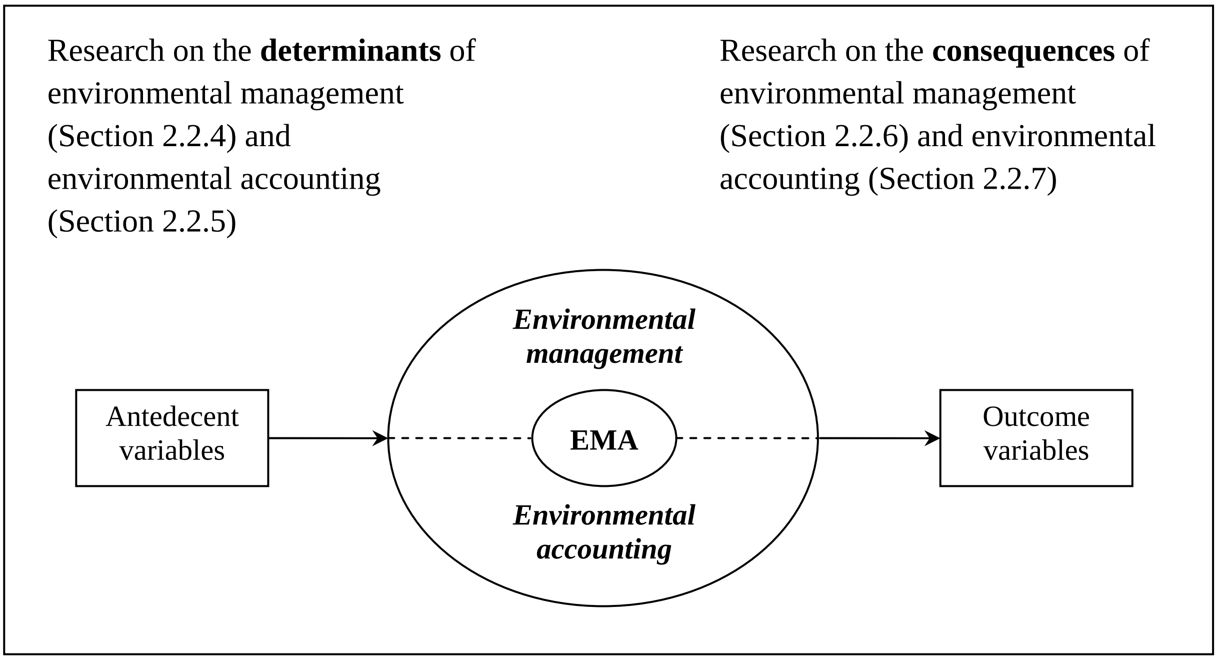
In conclusion, in recent years there has been a growing interest about environmental accounting practices as emerged from an overview of the popular literature and the proliferation of technical guidelines in the field. It appears that the diffusion of these practices is widely occurring, though at different pace in different countries. As with any novel field, however, there is a paucity of descriptive and explanatory studies concerning this phenomenon. This is particularly evident in the sub-specialty of environmental management accounting, which was allocated a specific role in the accounting field only a decade ago (cf. Milne, 1996). A review of the limited literature covering environmental management accounting, environmental performance measurement and control is provided in the next sections.

This dissertation aims to contribute to the mainstream, *"business case"* literature in management accounting and control. Therefore, in the literature review presented next I will predominantly consider empirical studies in environmental accounting published in mainstream accounting journals or recent academic papers that are representative of current developments in the area. The studies belonging to more interpretative or critical perspectives that deal with performance measurement and control will be marginally discussed, in order to complement the analysis of the field study presented in Chapter 6 of this dissertation. In fact, the case attempts to combine both a positive and an interpretative approach in order to generate more insightful and complete understanding of the phenomena investigated in the case company.

2.2.3 Framework to organize the literature overview

As is clear from the above, two essential problems can be encountered when attempting to research environmental management accounting (EMA). First, despite its increased relevance in practice documented by accounts from popular literature, academic research has been very limited on this topic and this renders the research approach necessarily exploratory. Second, the limited literature around this topic goes beyond a single discipline. To structure the remainder of the review I will now attempt to delimit the boundaries of the fragmented, multidisciplinary literature that – directly or indirectly – examined EMA by providing an overview of two bodies of literatures. I will consider the academic literature that has investigated environmental management using managerial and organizational theories (labelled in this study as "environmental management" strand of research). In addition, I will briefly review and discuss scholarly research in accounting that investigated environmental-related issue (labelled in this study as "environmental accounting" strand of research). I propose here to organize and evaluate both research areas along two main groups of studies. The first one addresses the reasons why organizations introduce environmental management and environmental accounting practices. I label this stream as *determinants* of environmental management and environmental accounting. This stream addresses those factors that drive adoption and use of environmental management and environmental accounting practices in organizations. The second group comprises studies examining the *implementation* as well as the *consequences* that are caused by environmental management and environmental accounting practices. This group includes the initial body of literature focused on adoption and implementation processes in management studies, together with the more established stream that investigates their effects on outcome variables like environmental performance and financial performance. Figure 2.1 illustrates the framework used to organize and present the literature overview.

Figure 2.1 – Framework for the review of empirical academic research in environmental management and in environmental accounting



The choice of clustering the scholarly literature around two main groups of studies is consistent with the focal theme investigated in this dissertation. It is also consistent with previous partial attempts to classify and review the literature in environmental management (cf. Fuchs and Mazmanian, 1998; Christmann, 1999; Bowen, 2000b; Sharma, 2002; Sharma and Ruud, 2003). However, the boundaries of the review are particularly difficult to draw when dealing with fragmented academic research about environmental management. The same applies to the literature about environmental accounting, as clearly noted by Gray and Bebbington (2000:9):

> *"Attempting to review all the extant literature on environmental accounting would be fruitless"*.

The intention in this chapter is thus not to provide an exhaustive review of both areas of research. I will classify the streams of research and I will outline the articles that are most informative about the research topic of this dissertation.[5] The overview is structured around studies that used the same theoretical approach and the same level of analysis. The overview concentrates on the organizational level of analysis (cf. Luft and Shields, 2003) because the studies comprising this dissertation focus on this level.

2.2.4 Determinants of environmental management

A stream of research has addressed the following research question from different disciplines in economics and business administration: *What factors do explain the adoption of environmental management initiatives?* At a conceptual level, several factors have been identified and investigated. Compliance to environmental regulation is the explanatory variable that has received most attention both in the management and economics literature (see Rugman and Verbeke, 1998 for a review). The importance of legislation in inducing environmental management adoption can be related to the recognition by firms of potential risks associated to (1) unacceptable process and product impacts resulting in regulatory changes; (2) non-compliance penalties of all kinds; (3) product elimination, substitution, and phase-out; and (4) the banning or restriction of raw materials (Henriques and Sadorsky, 1996). Other researchers have comprised in their conceptual analysis supplementary external factors. For example, Porter and van der Linde (1995) argued that firms seek to maximize "resource productivity" in response to both regulatory and market pressures, enabling them to simultaneously improve their industrial and environmental performance. Similarly, Hoffman (1999a) proposed additional types of external forces that, in combination with regulatory forces, exert pressure to adopt environmental management practices: market drivers, resource drivers and social drivers. Market drivers refer to those constituents (consumers, trade associations and competitors) that influence companies to consider environmentalism in their business strategies. Resource drivers consist of buyers and suppliers, insurance companies, shareholders and investors that affect the acquisition, processing and distribution of products or services along the supply chain. Further, social drivers include corporations' external stakeholders like citizens groups, environmental groups and the media. Building upon prior frameworks, Bansal and Roth (2000) synthesized previous conceptualizations and combined external and internal drivers in a framework that groups three types of antecedents, labelled as: (1) *legitimization*, which reflects the need of a firm to improve the appropriateness of its actions within an established set of regulations and norms; (2) *competitiveness*, which relates to (potentially positive) economic considerations affected by the adoption of environmental management and the generation of long-term profitability; and (3) *social responsibility*, which stems form the voluntary concern that a firm has for its social obligations and values.

The empirical evidence about the role of these antecedent factors is examined by an expanding body of literature that investigates determinants of environmental management initiatives at the organizational level of analysis.[6] Table 2.2 classifies the most representative studies.

This overview posits a broad distinction between studies that explains the drivers behind (1) adoption of initiatives that generically reflect voluntary approaches towards improvement of environmental performance, from (2) explanatory variables of adoption and certification of environmental management systems according to ISO 14001. The empirical studies draw upon different theoretical paradigms as reviewed in Andrews (2001) and EPA (2003). Some studies adopt an approach typical of *contingency theory* (Husted, 2000 provides a review of contingency reasoning applied to the area of corporate social performance), in which contextual and structural variables are posited to "fit" with specific features of environmental management systems. For instance, Klassen (2001) and Klassen and Whybark (1999a) investigated the driving factors behind the adoption of pollution prevention technology at the plant level in the furniture industry.
Elements of both plant managers' personal views and plant-level characteristics were significantly related to environmental management orientation (operationalized using three related factors labelled as *systems analysis and planning, organizational responsibility* and *management controls* as reported in Table A.1). Consistent with expectations, empirical evidence strongly indicated that a plant manager's increased emphasis on short-term economic value was significantly related to having a more *reactive* plant-level environmental management orientation. In contrast, increased emphasis on ethical and environmental values was significantly related to a more *proactive* orientation. Klassen (2001:273) suggested therefore that:

"The development of proactive orientation can occur when senior corporate managers implement reward systems, which stress a balanced scorecard that encompass a broad array of financial, operating and social measures instead of a narrow emphasis on short-term economic performance".

More recently, Banerjee *et al.* (2003) provided evidence that in high environmental impact industry the antecedents of environmental strategy were top-management commitment, public concern for the environment, regulatory forces and competitive advantage (ranked in order of decreased importance). In turn, in the context of ISO 14001 adoption, Nakamura, Takahashi and Vertinsky (2001) found that the costs and benefits of voluntary actions are significant determinants of environmental commitment. At the same time, the environmental values, attitudes and beliefs of key managers increased significantly the explanatory power of their predictive model.

Table 2.2 – Overview of representative empirical studies that examined determinants of environmental management at the organizational and sub-unit level of analysis

	Environmental management operationalized as:	
Theoretical domain	**Different environmental management practices**	**ISO 14001 Environmental Management System**
Contingency-based approach	Klassen and Whybark (1999a) Klassen (2001) Banerjee, Iyer and Kashyap (2003)	King and Lenox (2001b) Nakamura, Takahashi and Vertinsky (2001) Quazi, Khoo, Tan and Wong (2002) Bansal and Bogner (2002) Bansal and Hunter (2003) King, Lenox and Terlaak (2004)
Institutional theory	Hoffman (1999b) Milstein, Hart and York (2002) Delmas and Toffel (2005)	Delmas (2002)
Stakeholder theory	Henriques and Sadorsky (1996; 1999) Braglia and Petroni (2000) Buysse and Verbeke (2003)	
“Beyond compliance” and regulatory effects at macro level	Arora and Cason (1995) Khanna and Damon (1999) King and Lenox (2000) Videras and Alberini (2000) Davidson and Worrell (2001) Sharma (2001) Kassinis and Vafeas (2002) Khanna and Anton (2002)	

Similarly, Quazi, Khoo, Tan and Wong (2002) identified in top-management commitment the most important factor in predicting the adoption of ISO 14001 in a sample of chemical and electronic industries in Singapore. In turn, King and Lenox (2001b) found evidence in a sample of about 17,000 manufacturing facilities in the US that the adoption of ISO 14001 was higher for companies that engaged in extensive research and development programs, and were already certified ISO 9001.

Another group of studies is informed by *institutional theory* (cf. Meyer and Rowan, 1977; DiMaggio and Powell, 1983; Scott, 2001) to explain the adoption of environmental management initiatives. Jennings and Zandbergen (1995), Ehrenfield (2002), Scott (2002) and Delmas and Toffel (2004) provide more detailed discussion over institutional theory in the study of organizations and the natural environment. As far as empirical findings, Hoffman (1999b) examined how different institutional pressures shape the perception and acceptance of environmental management within firms. Using both a detailed case study and later a large sample in the chemical industry, he traced over a period of decades how coercive, followed by normative and mimetic, forces caused organizational actors to reject and later to embrace the natural environment as a strategic issue. By using a simple *t*-test in a sample of US company, the results in Milstein, Hart and Ilinitch (2002) indicated that higher variance in environmental strategy is observed among a set of firms in an industry with a significantly higher coercive pressure, while low strategic variance is observed among firms in an industry with lower coercive pressure. The researchers thus contend that coercive institutional pressures increase the heterogeneity of strategic responses, while mimetic and normative pressures are driving isomorphism across firms in the same industry. More recently, Delmas (2002) and Delmas and Toffel (2005) applied insights from institutional theory to explain the adoption of environmental management systems and ISO 14001 in particular.

Other academic contributions apply *stakeholder theory* to explain why companies “go green” (cf. Driscoll and Starik, 2004 for a review about stakeholder theory). The stakeholder approach has been applied by Henriques and Sadorsky (1996) to demonstrate that environmental regulation does represent the single most important source of pressure on firms to consider environmental issues in the Canadian context. In another article (Henriques and Sadorsky, 1999), the same authors indicated that firms with more proactive profile do differ from less environmentally committed firms in their perceptions of the relative importance of different stakeholders (regulatory stakeholders, community stakeholders and organizational stakeholders). Braglia and Petroni (2000) investigated the relationship between the adoption of product stewardship practices and the involvement of different stakeholders in the decision-making process. A discriminant analysis suggested that firms that are more committed to product stewardship differ from less-committed firms in the influence exerted by different stakeholders and in the supportive role played by the management at different functional and hierarchical levels. Further, the results of a survey conducted in Mexico by Wisner and Epstein (2001) indicated that regulatory pressure was a significant antecedent, together with industrial association structure and ownership structure. More recently, Buysse and Verbeke (2003) found that environmental proactive orientation was associated with actively managing the norms and expectations of various stakeholders other than regulators. However, not all stakeholders appeared to be perceived as equally important for firms with a proactive environmental strategy. More specifically, only the linkage between environmental strategy and internal, primary stakeholders appeared rather strong. The paper concluded that the key stakeholders might vary substantially depending upon the environmental strategy chosen and the relevant institutional context faced by the firm.

Finally, the role of *environmental regulation* as driving force has been extensively studied in the environmental economics literature, in particular to examine why companies voluntary tend to over-comply (cf. Arora and Gangopadhyay, 1995; Reinhardt, 1999b; Coglianese and Nash, 2001; Prakash, 2001; Gunningham, Kagan and Thornton, 2003). Several empirical studies argue that the threat of present and future regulation and the opportunity to increase economic value in various ways (such as efficient gains, product differentiation or enhanced market reputation) constitute significant explaining reasons for the adoption of voluntary environmental approaches. For instance, Arora and Cason (1995), Khanna and Damon (1999), Videras and Alberini (2000) and Khanna and Anton (2002) provided evidence that the threat of regulation motivated firms to adopt the environmental program US EPA 33/50.

In summary, the stream of academic contributions seeking to explain contextual and organizational antecedents of environmental management has expanded considerably in the last decade. Theory development in this area is informed by different studies that collectively emphasize the interrelated role of regulatory, legitimacy and competitive issues as driving factors towards more proactive environmental management practices. It appears also that most of the studies used an *outside-in* approach for investigating the interactions between organizations on one hand and governmental agencies, competitors and stakeholders pressures on the other.

2.2.5 Determinants of environmental accounting

The overwhelming majority of empirical research in mainstream accounting literature that examined the determinants of environmental accounting should be classified as financial accounting research. In that area, the environmental accounting practice mostly investigated refers to the provision of environment-related information to external stakeholders through environmental reporting. In general, three reporting mechanisms can be used to convey environmental information to stakeholders: (1) voluntary corporate disclosure; (2) external sources of disclosure; and (3) mandatory corporate disclosure. Whilst most of scholarly work regarding such disclosures tends to focus on data contained within the corporation’s annual report, a wide range of other media may be employed (the realm of environmental disclosures encompasses various items as reviewed in Cormier and Magnan, 2003). Prior research shows that the extent of such disclosures varies both across firms and across time (e.g. Blacconiere and Patten, 1994; Gamble, Kite and Radkte, 1995). A growing body of research is focusing on the explanatory factors behind extant variation of voluntary environmental disclosures. From a broad perspective, this literature can be organized into two separate research paradigms. The first stream adopts socio-political theories of social and environmental disclosure, among which *legitimacy theory* is the conceptual framework most often used. The second stream adopts an economics-based approach that is rooted in *voluntary disclosure theory* in financial accounting research. I will briefly illustrate the main theoretical and empirical insights from both areas of research published in mainstream accounting journals, though exhaustive literature reviews are available in recent articles (Walden and Schwartz, 1997; Bewley and Li, 2000; Cormier, Magnan and Velthoven, 2001; Gray, Javad, Power and Sinclair, 2001; Deegan, 2002; Berthelot *et al.*, 2003).[7]

In the first group of studies, environmental accounting and reporting are seen as corporate initiatives to respond to public pressures exerted by various stakeholders and constituencies. Public pressure in the social/political environment is identified as consisting of both social changes and regulatory effects. Thus, public pressure can arise because of the concerns of the general population, political bodies or regulatory agencies (Walden and Schwartz, 1997). Researchers refer to *legitimacy theory* in this area: the theory rests on the concept that organizations have implicit contracts with society and fulfilling these contracts legitimates the organizations and their operations (cf. Deegan, 2002 and Section 2.2.2). According to this theory, differences in public policy pressures lead to differences in the extent to which companies disclose environmental information. As a result, changes in these pressures lead to changes in the extent of environmental disclosure (cf. Milne and Patten, 2002; Cormier, Gordon and Magnan, 2004 for detailed reviews of legitimacy theory). Several empirical studies have provided evidence of increased environmental disclosure in response to amplified public policy pressures. A part of the research employed accounting and financial statements with a longitudinal approach of one company or industry. For instance, Patten (1992) used legitimacy theory to explain changes in environmental disclosures by North American oil companies after the Exxon Valdez oil spill. As expected, the oil spill represented a threat to the reputation associated to the industry and forced oil companies to increase environmental disclosures in their annual reports in the period subsequent the environmental disaster. Other studies examine variation in environmental reporting across a sample of companies located in a specific country. In the Australian context, for example, Deegan and Gordon (1996) found that companies' environmental reporting was positively related to the increase in environmental interest groups. In addition, industry's environmental sensitivity was positively correlated with the amount of disclosure made by corporations belonging to a specific industry. The effect of media coverage on the level of environmental disclosure has been investigated among others by Brown and Deegan (1998). In a sample of Australian companies, they found that increased print media attention on environmental issues resulted in higher levels of environmental disclosure.

Another factor considered as determinant of environmental disclosure has been the level of environmental performance. Researchers adopting legitimacy theory posit that companies facing greater environmental exposure (i.e. poorer environmental performance) would be expected to provide more extensive environmental disclosures. Hence, a negative correlation is posited between environmental performance and environmental disclosure. To date, empirical findings are inconclusive about this conjecture. Some studies did not provide support to the theory (e.g. Ingram and Frazier, 1980; Wiseman, 1982). On the contrary, Patten (2002b) empirically found a significant relation between environmental performance and environmental disclosure, supporting the argument that the level of disclosure is a function of the exposure a company faces in its socio/political environment.

In contrast to being influenced by public pressures, corporate environmental reporting can also be strictly viewed as an economic decision by management, based on a financial assessment of the various costs and benefits to be derived from additional disclosure. Discretionary disclosure models rooted in *agency theory* provide a theoretical framework in which the benefits of disclosure can be weighted against the proprietary costs incurred by a company to disclose (see Verrecchia, 2001 for an extensive review on discretionary disclosure models). For instance, by reassuring a firm’s investors about various aspects of its operations or performance, expanded disclosure are expected to lead to a reduction in information asymmetry between managers and investors (Kim and Verrecchia, 1994). This, in turn, brings benefits to a firm by allowing it to lower its cost of capital, to raise its valuation multiples, to increase stock liquidity and to enhance interest by institutional investors (Healy, Hutton and Palepu, 1999). Therefore, firms with good environmental performance would disclose more environmental information (both in quantity and quality) in comparison with firms with poorer environmental performance (cf. Toms, 2002; Mitchell, Percy and McKinlay, 2004). By contrast, disclosure can be costly to the firm if outside parties use the information in ways that are harmful to its interests (e.g. sensitive environmental-related information that is used by competitors or pressure groups represented by Non-Governmental Organizations). Corporate pollution often makes for negative headlines in the media, with potential harmful effects in terms of the political and economic costs involved for being identified as an environmentally irresponsible company. The Shell’s Brent Spar case represents a well-known example about high reputation costs involved in stakeholders management (cf. Grolin, 1998). On the other hand, by incurring these proprietary costs, a firm enhances the credibility of the information being released and hence improves its reputation for being a “quality discloser”. Consequently, managers may want to increase the extent of a firm’s environmental disclosure to build up support among its various stakeholders. Following this line of reasoning, in choosing a reporting strategy, managers have to trade off the benefits from expanded disclosure against the costs of disclosing potentially damaging information. A limited number of empirical studies (Barth and McNichols, 1997; Li, Richardson and Thornton, 1997; Cormier and Magnan, 1999) provide evidence that firms do adopt a strategic posture that takes into account cost and benefits when disclosing – or not – environmental information. These studies suggest that management may disclose environmental liability information in a strategic fashion, with disclosure decisions being influenced by outsiders’ knowledge of the firms’ environmental problems, its pollution propensity, and its political exposure (e.g. the risk of it being adversely affected by corporate environmental stakeholders).

To sum up, both streams of research concur that different factors affect reasons and extent of environmental disclosures. Both social-political theories and economics theory provides an explanation of environmental reporting choice. A summary of the evidence from these studies suggests that firms' voluntary environmental disclosure increases with (adapted and extended from Berthelot *et al.*, 2003:18):

- Firm size and membership in environmentally-sensitive industries such as oil and gas, pulp and paper products or utilities (Patten, 1992; Barth and McNichols, 1997; Neu, Warsame and Pedwell, 1998; Bewley and Li, 2000; Cormier and Gordon, 2001);
- The extent a firm is widely-owned (Patten, 1992; Cormier and Magnan, 1999; Cormier and Magnan, 2003);
- A firm's exposure to environment-related legal proceedings or fines related to non-compliance to environmental regulation (Deegan and Gordon, 1996; Neu *et al.*, 1998);
- A firm's media exposure of its environmental activities (Li *et al.*, 1997; Brown and Deegan, 1998; Neu *et al.*, 1998; Bewley and Li, 2000; Patten, 2002a; Cormier and Magnan, 2003);
- The probability of being involved in similar environmental accidents in the future (Walden and Schwartz, 1997);
- Environmental lobby groups' concerns about a firm's environmental performance (Deegan and Gordon, 1996).

Determinants of environmental management accounting

While environmental accounting research in the financial accounting field is rather established, a few empirical studies have been carried out from a management accounting perspectives on determinants of environmental management accounting systems. The study by Campbell, Sefcik and Soderstrom (2000) extends compensation research in accounting literature by considering implications of environmental performance - regarded as specific non-financial metric - as a determinant of CEOs' compensation in the United States. The empirical findings presented evidence consistent with the existence of a risk premium compensating CEOs for incremental environmental-related personal and economic risks in more environmentally sensitive industries. Similarly, in a survey addressing CFOs of Australian companies, Frost and Wilmhurst (2000) investigated the adoption of environment-related management accounting procedures, hypothesizing that firms in more environmentally sensitive industries are more likely to have adopted such procedures. The study fails to provide conclusive evidence of a significant difference between sensitive and less-sensitive industries on a range of cost accounting and management control practices. In effect, half of the companies surveyed (n = 121) reported that they were not including environmental information within their existing accounting systems. The study supports findings that environmental costs are not being appropriately identified and allocated by accounting systems (Ditz *et al.*, 1995; Epstein, 1996; Bartolomeo *et al.*, 2000; Parker, 2000a, 2000b). As a consequence, the costs of environmental regulation tend to remain hidden in overhead cost categories and not appropriately allocated to product costs. This result was confirmed by the study by Joshi, Krishnan and Lave (2001) in the steel industry, which revealed that the associated hidden costs of environmental regulation amount to eight to ten times the visible costs at the margin. Another empirical study by Wisner and Epstein (2001) investigated the role of external drivers in environmental management responsiveness in a sample of Mexican companies. They found that regulation, but also industry association, customers' pressures and ownership structure were significant factors in influencing management control practices that include dimensions of environmental performance. Finally, Pondeville (2003) applies a contingency approach to explore the role of contingency factors like *environmental uncertainty, stakeholders' pressures* and *environmental strategy* on management control systems in a sample of Belgian companies. The study found a positive relationship between perceived stakeholders' pressures and *broad scope* environmental information system, which was mediated by the intensity of environmental strategy. Contrary to expectations from prior literature in management accounting, a negative association was found between perceived environmental uncertainty and *broad scope* environmental information system. This study provides interesting avenues for further research on design and effects of environmental performance measurement systems, part of which will be further explored in this dissertation.

To conclude this section, the main focus of environmental accounting research has been on financial accounting-related topics. Research with a managerial accounting emphasis is nearly non-existent. The overview points at the need to further examine internal aspects of environmental performance measurement in order to better understand external effects of environmental accounting on organizational performance.

2.2.6 Consequences of environmental management

As for most of the management initiatives, one of the questions that primarily attract the attention of researchers and practitioners is to know whether there are competitive advantages and opportunities associated with environmental management: *What are the effects associated with the adoption of environmental management initiatives?* An increasing number of studies addresses this research question from different literatures, theoretical approaches and data collection methods. The outcome variables investigated vary considerably and an overall classification is problematic to organize. In a broad sense, researchers examined three issues.

The first issue concerns organizational and individual processes that are associated with the implementation of environmental management practices in organizations. The body of literature that investigates internal processes of environmental management applies organizational and psychological theories in order to inform about the behavioral mechanisms involved in environmental management. The general objective of these studies is to illustrate and explain processes without linking them with *effectiveness* outcome variables. At the organizational level of analysis, King (1995) employed a contingency-based approach to explain how companies design their environmental functions to cope with external uncertainty. In another study, King (2000) applied a "punctuated equilibrium" model of organizational dynamics to investigate how companies design and change their internal structures to face environmental regulation changes. A conceptualization of internal processes of environmental management was proposed and empirically tested by Winn and Angell (2000): their typology addressed two independent dimensions of environmental management (policy commitment and approach to implementation) that reflect the dynamics of internal processes not yet investigated in prior research. More recently, researchers started to incorporate cultural aspects associated to environmental management (Harris and Crane, 2002) and to issues concerning workers' participation in environmental management programs (Howard, Nash and Ehrenfield, 2000; Rothenberg, 2003).[8] With regards to research indirectly related to managerial accounting and control in this strand of research, Sharma (2000) did not find evidence that the performance evaluation of managers had an effect on managerial interpretation concerning environmental issues. Theories and empirical findings from organizational behavior literature was also used by Ramus and Steger (2000) to develop hypotheses about the role of supervisory support behavior in enhancing participation of employees in corporate environmental protection initiatives. The authors demonstrated that incentive systems were positively correlated with eco-initiatives. Chinander (2001) explored the role of internal responsibility and reward systems using a framework from *expectancy theory*. The empirical study carried out in a manufacturing plant described internal systems used to operationally implement an environmental strategy. The author concluded that the difficulty to see the direct connection between one's action, potential consequences of those actions and rewards/punishments in the environmental area makes the performance measurement and control systems critical factors in determining a firm's level of environmental excellence (see also Killmer and Ramus, 2004). Another set of studies focusing on implementation aspects of environmental management examined the issue of integration of environmental functions in organizational structures. Avadikyan, Llerena and Ostertag (2001) conceptualized the diffusion of EMS drawing upon evolutionary theory of the firm. Studies focused on formal structure of environmental departments (Atkinson, Schaefer and Viney, 2000), or examined cross-functional integration and coordination mechanisms among departments (Fryxell and Vryza, 1998) particularly in the context of "green" product development (e.g. Pujari *et al.*, 2003; Blomquist and Sandström., 2004).

The second strand of empirical research focused on the relationship between certain features or components of environmental management systems (e.g. environmental strategy, pollution-technology, structure of environmental functions) and outcome variables mostly represented by environmental performance or financial performance. The research question addressed by these studies is whether the adoption of various systems for environmental management had an effect on firms' environmental profile and, through enhanced environmental performance, on firms' competitiveness. Early researchers argued that increased environmental regulation could lead to unproductive investments, higher cost of compliance and a possible loss of competitive advantage (e.g. Jaffe, Peterson and Portney, 1995). Others contended that stringent environmental regulation presented firms with the opportunities for improved efficiency (Porter and van der Linde, 1995; Dasgupta, Hettige and Wheeler, 2000) and international competitive advantage (Porter, 1991). Indeed, studies showed that first movers, by moving beyond environmental regulatory compliance, created entry barriers that favoured industry incumbents (Dean and Brown, 1995) and provided them with sources of competitive advantage in international markets (Nehrt, 1998). Other scholars adopted a more internal-oriented focused and examined the extent to which complementary assets like pollution prevention technology are required to gain cost advantage from implementing environmental management best practices (e.g. Klassen and Whybark, 1999b; Christmann, 2000; Delmas, 2001). The studies mostly representative of this area draw on *resource-based view* of the firm (Barney, 1991; Teece, Pisano and Shuen, 1997; Barney, 2001), which provides a theory to explain competitive advantage as an outcome of the development of valuable organizational capabilities (cf. Aragon-Correa and Sharma, 2003; Marcus, 2004 for a review of this literature). In the context of environmental management, Hart (1995) proposed that such a view of the firm must be adapted to take into account diverse environmental constraints affecting current competition, and that there are environmentally oriented resources and capabilities with the potential to generate sustainable competitive advantages. Sharma and Vredenburg (1998) in a study of Canadian oil and gas industry identified three key organizational capabilities derived from environmental management: (1) socially capability for stakeholder integration, that is to say, capabilities for influencing stakeholders, mitigating their pressures or sharing their visions; (2) capability for higher-order learning, referring to the tendency of companies to explore new alternatives and generate new interpretation of existing procedures; and (3) capability for continuous innovations, given that greater richness of perspectives and analyses in the learning process contributes to generating technological, organizational and operational innovations on a continuous basis (e.g. trough the application of total quality management techniques). These capabilities are complex and path dependent (Barney, 1991) on the accumulation of, and the interaction among, resources such as physical assets, technologies and people (Shrivastava, 1995). In this line, Russo and Fouts (1997) confirmed over a sample of 243 companies that high levels of environmental commitment are associated with enhanced profitability, this relationship being stronger in industries showing high levels of growth. The effect on business performance is explained because environmentally proactive companies own some distinctive resources, like: (1)

physical assets and technology, which might not be a source of differentiation by themselves, but might lead to distinctive capabilities and knowledge in environmentally proactive companies; (2) human resources and organizational capabilities, presumably because it is easier for proactive companies to attract top candidates; and (3) intangible resources, such as reputation and the ability to influence public policies to achieve competitive advantages. Other empirical studies confirmed a positive relationship between proactive environmental management and organizational performance taking on a *natural* resource based view of the firm (e.g. Judge and Douglas, 1998; Marcus and Geffen, 1998; Klassen and Whybark, 1999b; Christmann, 2000; Delmas, 2001; Majumdar and Marcus, 2001). Another set of studies, largely in operations management, examined the effects of environmental management practices without relying upon a specific theoretical framework (e.g. Klassen and Whybark, 1999a; 1999b; Melnyk, Calantone, Handfield and Tummala, 1999; Hanna, Newman and Johnson, 2000; Gil, Jimenez and Lorente, 2001; Klassen, 2001; Melnyk *et al.*, 2003; Zhu and Sarkis, 2004). Among them, the study by Klassen and Whybark (1999a) is particularly illustrative of the interrelationships between environmental management and management control. The study considered the association of management controls, the adoption of pollution prevention technologies and environmental performance in a sample of plants in the US furniture industry. Evidence was found that the companies with higher reliance on management controls and pollution prevention technology were associated, as expected, to lower levels of toxic releases in the industry.

The third group of studies examining the effects of environmental management comprises a relatively large number of studies that attempt to empirically detect a posited positive relationship between environmental performance and financial performance. Given the extensive overlap between research in environmental management and in environmental accounting about this issue, I will refer to the literature in both areas in the next section. It is worth noting that researchers in environmental management and accounting researchers did not tend to build upon both literatures. It appears instead that the area is still highly fragmented, particularly because available contributions belong to different academic fields.

In conclusion, different outcome variables were investigated as a consequence of environmental management implementation. According to the theory applied and the literature of reference, a broad distinction can be drawn between (1) *behavioral* criterion variables, particularly at managerial level, and (2) *organizational* measures of performance defined differently to encompass environmental efficiency, financial performance or manufacturing performance. Given the novelty of the field, it is rather premature to generalize from the available literature. A positive sign for the further development of the field appears the attempt to embed the analysis of environmental management into mainstream debates and literatures concerning implementation of strategic choice, organizational change, and issue management from traditional business literature.

2.2.7 Consequences of environmental accounting

Similarly to the literature that investigated the antecedents of environmental accounting practices, academic research that examined the effects of these practices was prevalently carried out from a financial accounting – and thus externally-oriented – perspective. Over the last thirty years, (financial) accounting researchers have addressed the *"does it pay to be green"* hypothesis in parallel with developments in various disciplines investigating corporate social and environmental performance (CSP)[9] and corporate financial performance (CFP), the so-called empirical CSP-CFP literature. A number of narrative reviews (e.g. Ullmann, 1985) have proposed conceptual explanations for the existence (or lack thereof) of a causal relationship between CSP and CFP, but failed to provide generalizable answers. The debate on the relation between environmental performance and shareholder value is divided into two schools (cf. Assabet Group, 2000). The *cost concerned* school argues that environmental investments represent only increased costs with decreased residual incomes and lower market values. The *value creation* school, on the contrary, sees environmental efforts as a way to increase competitive advantage and improve financial results to the investors. The empirical literature devoted to solve this dilemma increased substantially in the last decade. Fairly thorough reviews of empirical studies in this stream of literature have been published in the popular business literature in the past years (cf. Adams, 1998; Aspen Institute, 1998; Reed, 1998; EPA, 2000; Repetto and Austin, 2000; Blake Goodman, Kron and Little, 2002; Forum for the Future, 2002; Murphy, 2002; GEMI, 2004; White and Kiernan, 2004 for recent reviews). Taken together, the tone of these reviews is quite normative, as these collections of prior results ultimately tend to demonstrate a positive link between CSP and CFP. Two recent academic articles provide exhaustive reviews of the literature and attempt to summarize the wide amount of empirical results that has been published. According to Margolis and Walsh (2003:273), 127 published studies empirically examined between 1972 and 2002 the relationship between companies' socially responsible conduct and their financial performance. They reported that CSP has been treated as an independent variable, predicting financial performance, in 109 of the 127 studies. The authors, using a so-called "vote counting" technique (i.e. simple compilation of the findings), found that 54 studies pointed to a positive relationship between CSP and CFP. Only 7 studies found a negative relationship, 26 reported non-significant relationships, while 29 reported a mixed set of findings. On the contrary, studies treating CSP as dependent variable, predicted by CFP, amounted to 22 of the 127 studies. In 16 studies, a positive relationship between CSP and CFP was detected. On the basis of the review, Margolis and Walsh (2003) concluded that the link between CSP and CFP remains disputable, though empirical findings slightly pointed at a positive relationship. By referring to a reverse argument, it is plausible to conclude with more certainty that a *negative* association was *not* detected from 127 empirical studies. In another recent literature review, Orlitzky, Schmidt and Rynes (2003) conducted a meta-analysis of the CSP-CFP relationship, claiming that this technique allows for more precision than other forms of research reviews.[10] The authors retrieved 52 studies representative of the population of prior quantitative studies in the CSP-CFP literature, yielding a total sample size of N = 33,878 observations (k = number of effect sizes integrated = 388 correlations). Overall, the mean observed correlation for the total set of 388 correlations is 0.18 with an observed variance of 0.06. After correction for sampling and measurement error, the corrected correlation increases to 0.36, with a variance of 0.19.

With regard to academic research in environmental accounting, recent papers provide literature reviews with a clear orientation towards explaining environmental performance - financial performance linkages from a financial accounting perspective. (Koehler and Cram, 2001; Raar, 2002; Berthelot *et al.*, 2003; Hunt III, Garrity and Grinnell, 2003). Three clusters of studies (labelled here as *"event studies"*, *"multivariate studies"*, and *"portfolio studies"*) can be compiled to summarize the variety of research methods and data collection approaches that have been used in the empirical literature from different disciplines (cf. Reed, 1998; Molloy, Erekson and Gorman, 2002; Hunt III *et al.*, 2003). They are briefly reviewed next.

Event studies

The first group of studies consists of stock market *event studies*, a research technique that compares the financial performance of a particular stock relative to that of the market after the announcement of news (either "good news" or "bad news") about a company's environmental and social performance. Some studies are published in management or in environmental management journals (Hamilton, 1995; Klassen and McLaughlin, 1996; Khanna, Quimio and Bojilova, 1998; Karpoff, Lott Jr. and Rankine, 1999; Gilley, Worrell, Davidson and El-Jelly, 2000). In the accounting literature, representative event studies are Shane and Spicer (1983), Blacconiere and Patten (1994), Blacconiere and Northcut (1997), Patten and Nance (1998), Jones and Rubin (2001) and Lorraine, Collison and Power (2004). Taken together, the majority of the empirical results show that stock prices do react in response to environmental news, with disclosure of poor environmental performance leading in the main to *short-run* declines in affected firms' stock market values. Event studies have also established the informational relevance of significant environmental events to investors while documenting their intra-industry effects. For instance, Bowen, Castanias and Daley (1983) examined the electric utility industry after the Three Mile Island nuclear accident; while Blacconiere and Patten (1994), examined the chemical industry in the wake of the Bhopal chemical leak. Both studies documented a significantly negative intra-industry effect. On the contrary, Patten and Nance (1998) found a positive intra-industry effect following the 1989 grounding of the Exxon Valdez disaster, because the spill triggered substantial price increases in the wholesale and retail gasoline markets.

Multivariate studies

The second stream of research contains a bulk of studies utilizing multivariate regression techniques to analyze the effect of changes in environmental performance on changes in (*long-term*) financial performance measures (with Tobin's q, Return on Assets, Return on Equity and Return on Investment as measures most often analyzed; cf. King and Lenox, 2001a). This group of studies represents by far the area with the highest number of contributions. Scholars from different disciplines (financial economics, financial accounting, environmental and social accounting, environmental management, general management) have investigated two issues. The first one, centered around the correlation between environmental performance and financial performance, led to conflicting results over time (e.g. Jaggi and Freedman, 1992; Hart and Ahuja, 1996; Stanwick and Stanwick, 1998; Dowell, Hart and Yeung, 2000; King and Lenox, 2001a, 2001b, 2002; Wagner, Schaltegger and Wehrmeyer, 2002; Wagner and Wehrmeyer, 2002). The evidence from the body of studies is not conclusive and the relation between environmental performance and economic performance is founded on contradictory theoretical support that prior empirical research has failed to clarify (cf. Al-Tuwajiri, Christensen and Hughes II, 2004). The review by Orlitzky *et al.* (2003) allows some tentative conclusion over the "pays-to-be-green" scholarly research. The authors interestingly investigate differences between social and environmental performance by disaggregating the entire set of representative contribution in the CSP-CFP literature into purely *social* performance measures (k = number of effect sizes integrated = 249 correlations) and *environmental* performance measures (k = 139 correlations). When the entire meta-analytic set was divided into these two conceptualizations of CSP, the findings show that the corporate environmental performance has a smaller relationship with CFP ($r = 0.06$, $\rho = 0.12$) than do all other measures of CSP ($r = 0.23$, $\rho = 0.47$). Additionally, measurement error and sampling error explained more of the cross-study variance of r in the corporate environmental performance subset than in the pure CSP subset. The authors suggest that the relatively lower correlation between corporate environmental performance and CFP is, in fact, much more consistent across industry and study contexts than the contradictory evidence that apparently emerges from the stream of the empirical studies available so far. The second topic refers to the effects of environmental performance on the market value of a publicly traded firm employing balance sheet valuation models. In this research stream, researchers tested whether or not increases in voluntary corporate environmental disclosures had an effect on the equity value of the firm embracing the methodology inherent within capital market research. Article representative of the empirical accounting research published in this area are Belkaoui (1976), Ingram (1978) and Richardson and Welker (2001), while Feldman *et al.* (1997), Konar and Cohen (1997) and Thomas (2001) are empirical studies that are published in other fields. In the same stream of studies, some researchers have focused on the value relevance of environmental disclosures provided by third parties. For instance, Barth and McNichols (1994), Blacconiere and Northcut (1997), Campbell, Sefcik and Soderstrom (1998), Hughes (2000) and Campbell, Sefcik and Soderstrom (2003) are studies carried out in the US analyzing the impact of EPA publicly available information about contaminated sites (which includes the number of Superfund sites for which firms are held responsible and estimates of each firm's decontamination costs) on companies' value. As a whole, findings collectively support the evidence that the information about environmental liabilities is value relevant. In sum, the empirical evidence generated from both streams supports the existence of an effect between environmental performance and firm stock market valuation, with deteriorating pollution performances generally being associated with stock market value declines. Investors appear to infer that, because of its pollution performance, a firm will bear various costs that will reduce its value. Such costs include direct expenses (such as legal fees and damage assessments), as well as indirect expenses (like higher maintenance and pollution control costs) or reputational costs (e.g. Jones and Rubin, 2001). There is also evidence that investors do rely on information sources that are external to the firms (e.g. the Toxic Release Inventory in the US) to evaluate the financial consequences of these firms' environmental management, even when the total cost incurred is likely to be more significant than the cost for the firms if they self-disclosed the information. In addition, it is clear that information disclosed as a result of mandatory accounting standards requirements is also value relevant, even if some studies raised concerns about the reliability of this information.

Portfolio studies

A third category of research uses the same data as the correlation studies but applies the measures to screen out companies with poor environmental performance. Some studies rely upon an analysis made by stratifying the sample and retrospectively or prospectively comparing average stock returns of different portfolios to determine whether environmental performance information is a favourable forecasting variable (e.g. Cohen, Fenn and Naimon, 1995; Gottsman and Kessler, 1998). The results in this area are ambiguous and depend on the time period in question, on whether measured returns are risk-adjusted and on whether the model portfolio is adjusted to reflect the composition of the benchmark (cf. Repetto and Austin, 2000). Besides these studies, a rising number of scholarly contributions attempts to assess whether the inclusion of social and environmental consideration in decision-making process hurts investments returns. The attention towards the topic amplified over the years given the increased availability of financial institutions that engage in Socially Responsible Investments (SRI) (see Section 1.1 and the special issue of *Organization & Environment*, vol. 16(3) 2003 on the current debate concerning SRI research). Opponents of SRI typically argue that the application of non-financial consideration to the investment process *must* result in lower investment returns because the number of investment opportunities is reduced. Since SRI works with a smaller investment universe, the critics of SRI expect that screened funds generate lower risk-adjusted returns in comparison with non-screened funds (refer to Geczy, Stambaugh and Levin, 2003 for a formal treatment of this argument). In contrast, proponents of SRI readily admit that the application of social and environmental principles will reduce investment opportunities but argue that the screening process delivers benefits that more than offset the loss of portfolio efficiency caused by the more limited investment set. A third way holds that, under normal conditions, there should be no meaningful difference between the long-term performance of a broad universe SRI funds and a broad universe of traditional investment funds that are managed with comparable mandates. Proponents of this view have divorced themselves from ideological debates about whether SRI funds *should* perform better or worse than traditional funds. Instead, they believe that SRI is a legitimate investment approach that can be expected to provide investment performance on par with investment funds that do not formally apply socially responsible screening (Phillips Hager & North, 2003). Given these theoretical competing views, the question of how SRI portfolios perform relative to traditional investment is an empirical one. Research into this question has been approached by comparing the performance of SRI indices with a) traditional stock market indices; and b) traditional, non-screened investment funds.[11] The empirical findings generally confirm that the screening process typically results in a smaller investment universe, increased monitoring costs, restricted potential for portfolio diversification and less ability to adjust to changing market conditions (Luther, Matatko and Corner, 1992). More importantly, these constraints typically have not resulted in reduced investment performance, with various studies showing screened funds have matched or out-performed non-screened funds or appropriate market benchmarks (representative studies are Hamilton, Jo and Statman, 1993; Guerard, 1997; Sauer, 1997; Waddock and Graves, 1997; Asmundson and Foerster, 2001; Bauer, Koedijk and Otten, 2002; Stone, Guerard, Gultekin and Adams, 2004).[12] These results apply as well to studies explicitly assessing the portfolio performance of funds adopting screening policies that are specifically environmentally-oriented (e.g. Clough, 1997; Derwall, Gunster, Bauer and Keedijk, 2004). As concluded by Hunt *et al.* (2003) with regards to this stream of research:

> *"Even though a well-diversified portfolio containing green firms (whatever they may mean) is able to outperform the market during a given time period, this is not enough to prove that a firm will be financially rewarded for making environmental capital investments. The studies so far suggest that the investor is probably not punished by 'going green', although one probably could not argue that the investor is likely to reap above-average rewards from such strategy".*

In summary, despite the extant literature points at a positive value on socially/environmentally responsible funds, the evidence may bee too anecdotal to provide definitive conclusions.

Consequences of environmental management accounting

As far as empirical studies that focused on environmental management accounting, there has been a paucity of articles investigating the topic. Lanen (1999) explored the effects of a non-financial measurement system for environmental purposes. The author carried out a field study at 3M, investigating the results of a five-year project on waste minimization in 55 plants. In particular, the study analyzed the impact of cross-sectional differences in plant characteristics on performance improvements in waste generation. The results indicated that growth in output had a significantly positive effect on plant performance gains, due to the use of newer technology and/or improved production processes. By contrast, the results did not support the hypothesis that annual gains in performance were positively related to the marginal benefits accruing to the division.[13] The role of management control in the implementation of environmental management systems has been preliminary conceptualized by Jansson, Nilsson and Rapp (2000) and empirically tested by Nilsson, Jansson, Kald and Rapp (2000). Based on a survey of 31 Swedish corporate groups, the research showed that the integration of the environmental management system with the corporate management control system was one of the key factors that affected a successful implementation. Besides that, the chances of establishing an environmentally driven mode of business development were substantially improved at corporate groups, where corporate strategy emphasized activity-sharing, while at the same time business-unit strategy emphasized differentiation. Finally, the exploratory study by Wisner, Epstein and Bagozzi (2002) contributed further to the understanding of the use and effects of management control systems for environment-related purposes. Using data collected from 215 large US firms, the study provided empirical evidence that the alignment of management commitment, strategic planning and proactivity led to enhanced environmental performance. The authors identified a number of factors (techniques, systems and managerial attitudes) that formed a "package" of formal and informal components in an environmental management control systems. To my knowledge, this was the first study addressing the interplay between environmental management and management control systems. The study confirmed the importance of further investigation over the role of internal performance measurement and control elements in order to improve our understanding of their final effects on environmental performance and other criterion variables.

To conclude, the outcomes of environmental accounting have been strongly addressed by researchers in financial accounting and other disciplines. More than thirty years of empirical findings provide some evidence about the relationship between CSP and CFP as summarized by the excellent review by Orlitzky *et al.* (2003:427):

> *"Theoretically, portraying managers' choices with respect to CSP and CFP as an either/or trade-off is not justified in light of 30 years of empirical data. This meta-analysis has shown that (1) across studies, CSP is positively correlated with CFP; (2) the relationship tends to be bi-directional and simultaneous; (3) reputation*

> *appears to be an important mediator of the relationship, and (4) stakeholder mismatching, sampling error, and measurement error can explain between 15 percent and 100 percent of the cross-study variation in various subsets of CSP-CFP correlations".*

In comparison with the body of literature that built upon the CSP-CFP link, the contribution of managerial accounting and control in affecting organizational and environmental performance is only initially explored and requires further analysis.

2.2.8 Evaluation of the literature in environmental management and environmental accounting

The overview presented above allows some considerations about the state of the literature in the area of corporate environmental management and environmental accounting. As far as the academic literature in environmental management is concerned, research in environmental management progressively evolved in terms of theory and methods applied. In their commentary of the state-of-the-art in environmental management literature, Starik and Marcus (2000) stated that "*the area has made great strides*" and it positively faced many of the criticisms of the early phase of literature development. Despite the recent developments, however, the field is restricted to a pre-paradigmatic state and the questions remains of whether Gladwin's (1993) criticism of the field (among others, lack of solid findings, failure to replicate earlier studies, reluctance to embrace hypothesis testing and inability to maintain sufficient distance from advocacy and ideology) is still valid now as it was over a decade ago. In this respect, there are topics that have been under-investigated and require further improvement. In particular, scholarly research focusing on internal processes of environmental management is still relatively limited if compared to the stream of studies addressing the link between environmental and financial performance that represents the area mostly investigated. Christmann (1999) emphasized shortcomings in extant literature about environmental management, like: (1) the organizational measures of performance and competitiveness have not been measured relative to the firms' competitors but in absolute terms; (2) firms resources and capabilities that can be expected to moderate the relationship between environmental strategies and competitiveness have not been considered. Asymmetries in firms' resources and capabilities have been often excluded at the industry level of analysis; (3) the characteristics of the environmental issues that can affect competitiveness through the formulation of environmental strategies have not been properly considered. She concluded, therefore, that:

> *"The environmental management literature lacks of a coherent theory that explains which environmental strategies can be expected to lead to competitive advantage under which firm specific and external conditions".*

This evaluation is in line with the argument advanced by Reinhardt (1998) that not all firms might be able to create competitive advantage through the implementation of environmental strategies: more attention, thus, should be paid to circumstances under which more proactive environmental strategies eventually contribute to enhance firms' competitiveness. These commentaries emphasize the need to further examine determinants and effects of environmental management, particularly focusing on the role of those internal organizational factors that can better explain its effects on organizational performance. This evaluation is echoed by King and Lenox (2001a:115) who concur that:

> *"Additional research is needed to explore how underlying firm characteristics affect the relationship between relative environmental performance and financial performance. The relationship between underlying capabilities and environmental management is likely to be complex and contingent. Environmental management and other capabilities may prove to be complementarities. Depending on industrial conditions, different bundles of capabilities may be important. Our research suggests that firm attributes and different strategies for environmental improvement may moderate the link. It suggests that 'When does it pay to be green?' may be a more important question than 'Does it pay to be green?'".*

In discussing the literature in environmental accounting, similar conclusions can be drawn after having emphasized the external, financial accounting orientation of extant accounting research. It can be argued that financial accounting research prevailed on managerial accounting research because of the increased availability of archival data over the last decade concerning external environmental reporting and environmental disclosures. The research objective most frequently addressed remains to explain the empirical relationships among environmental performance, environmental reporting and financial performance. Despite the proliferation of studies in this area, evidence of a positive statistical relationship between environmental and financial performance cannot be conclusively inferred from extant empirical literature (Berthelot *et al.*, 2003; Margolis and Walsh, 2003; Orlitzky *et al.*, 2003; Al-Tuwajiri *et al.*, 2004). Discussing this stream of literature, Koehler and Cram (2001) addressed fundamental problems related with the approaches adopted so far, including model choice, statistical methodology and assumptions about the mechanism by which information flows from firms to financial markets. These criticisms complement those available in the environmental management literature. The lack of conclusive results over the "strength" of environmental-related signals to the capital market can be attributed to a series of reasons. In particular, the issue of *causality* has been indicated as one of the main concern in the literature (see Ullmann, 1985 for one of the early criticism on this point). The question whether firms do poorly financially because of poor environmental performance could be actually reversed when assuming that only those firms that are financially robust are able to improve their environmental performance. As an overall evaluation of the state-of-the-art in this strand of literature, Koehler and Cram concluded that (2001:16):

> *"Without a clear model of the relationship between firm environmental practices and strategy overall and how it affects firm environmental performance, we cannot*

> *divine which constructed variables or proxy variables adequately represent firm environmental performance and whether the finding of a significant relationship with financial performance or lack thereof is merely a function of measurement error or noise in the model".*

This literature, therefore, seems to suffer two major drawbacks that are shared with the literature published in environmental management. Firstly, it has concentrated on the correlation of environmental performance (*outcomes*) with the financial bottom line, while dismissing conceptualization and empirical investigation over the key link between the formulation of environmental strategies and related environmental practices (*organizational structure* and *internal processes*) that could enhance financial performance. Secondly, researchers have not dedicated enough attention to the definition and measurement of validated instruments of environmental management and environmental performance constructs.

It is remarkable to note that the same limitations of the *"pays to be green"* literature are still affecting much of the debate in the corporate social performance (CSP) – corporate financial performance (CFP) link. As discussed by Griffin and Mahon (1997), the aggregate results of the empirical studies on the CSR–CFP relationship are often contradictory and ambiguous (recent debates on the link CSP-CFP are also discussed in Mahon and Griffin, 1999; Roman, Haybor and Agle, 1999; Barnett and Salomon, 2003; Entine, 2003; Margolis and Walsh, 2003; Orlitzky *et al.*, 2003; Waddock, 2003; Walsh, Weber and Margolis, 2003). Although the largest number of researchers has confirmed a non-negative relationship, this research lacks a theoretical rationale. In their commentary about recent developments of published research, Rowley and Berman (2000) sharply criticized this strand of research:

> *"What value to science – to understanding – we derive from CSP-CFP research even if unambiguous results are obtained? … Learning that CSP is positively or negatively related to FP does not help us understand how firms should behave (what behaviors lead to CSP), and/or what antecedent conditions influence CSP (besides CFP)".*

They continued concluding that:

> *"…the proliferation of CSP-CFP research is a function of the research environment (the researchers' objectives) rather than the appropriate research objectives. CSP-CFP research represents an attempt to legitimize the researcher and the business and society field, rather than build understanding that guides firms through social aspects of their decisions or reveal the factors influencing a firm's CSP. As summarized by Wood and Jones (1995), a positive relationship between CSP and CFP would provide credibility and legitimacy to CSP researchers, justifying the field within the economic and strategy paradigm. However, the weight given to CSP-CFP investigation in terms of the relative*

> *number of studies does not correspond to the small contribution toward research objectives".*

These criticisms support therefore the need to further explore internal processes of performance measurement and control systems if we aim to build knowledge about ultimate effects of environmental performance on financial performance. As argued by Margolis and Walsh (2003:289):

> *"Beyond their design, little is known about how companies internally control, monitor, and discipline their social initiatives. …Understanding the forms of control used to steer social initiatives toward their aims and exploring how those forms of control commingle with traditional forms of financial control is central to a descriptive research agenda".*

Consequently, theories of social reporting applied to contextual and corporate characteristics but without addressing internal organizational variables provide at best only a partial understanding of environmental accounting (Adams, 2002).

At last, with regards to the literature in management accounting and control, the research that investigated environmental-related aspects is still in a developing stage. The professional literature dominates the area, with a rather normative tone about the "best-practices" that companies must implement to effectively manage and control their environmental risks. An increasing amount of anecdotal evidence from case studies and surveys of practices reinforce the relevance of the topic and the interest from the practitioners' point of view. However, only few attempts have been made to examine environmental management phenomena in management accounting and control literature. As anticipated in the first chapter and illustrated in Section 2.2.1, environmental management represents a challenging empirical setting to test theories and findings from research in management accounting and control. Analogies in particular with quality management and other operational strategies make it an interesting empirical setting to explore. Recent developments in performance measurement in the field of environmental management and accounting allow an exploratory analysis about drivers and effects of environmental performance measures. Therefore, I will refer to mainstream management accounting literature in the next section to review prior findings on performance measurement choice and develop the theoretical framework that will be object of study in the empirical part of the dissertation.

2.3 Empirical research in management accounting about performance measurement choice

In this section I summarize the empirical research that examined performance measurement choice in management accounting and control literature. The overview focuses on studies at the organizational or sub-unit level of analysis because these are the levels of analysis investigated in the empirical part of the dissertation. As comprehensive and recent summaries of the literature have appeared elsewhere (Fisher, 1995; Chapman, 1997; Kren, 1997; Langfield-Smith, 1997; Birnberg, 1998; Fisher, 1998; Ittner and Larcker, 1998b; Hartmann and Moers, 1999; Indjejikian, 1999; Hartmann, 2000; Ittner and Larcker, 2001; Lambert, 2001; Otley, 2001; Chenhall, 2003; Luft and Shields, 2003; Merchant *et al.*, 2003; Otley, 2003; Sprinkle, 2003), the aim of this section is not to "re-review" a rather wide area of empirical research. I will limit the overview by presenting the main theoretical arguments and empirical findings from extant literature focused on performance measurement choice. Prior reviews usually make a distinction between two traditions or paradigms of research in this research area (cf. Ittner and Larcker, 2001; Covaleski *et al.*, 2003; Ittner, Larcker and Meyer, 2003a; Merchant *et al.*, 2003). The first research tradition can be labelled as *behavioral-based* research, as it is established in organizational and sociological theories. The object of this type of research is to investigate antecedents and performance effects of management accounting and control systems (MCS) design and use attributes for planning and control. The second strand of research is defined as *economics-based* literature since it mainly draws upon agency theory and organizational economics models. This group of studies focuses on explanatory factors concerning compensation and rewards criteria, mainly at the corporate level of analysis. In the next section, I review theory and findings from both streams of studies. Section 2.3.3 evaluates current evidence and suggests directions for further research to examine performance measurement choice in the field of environmental management.

2.3.1 Behavioral-based research

Research focusing on performance measurement choice as key element of a management accounting and control system traditionally relied upon *contingency theory* (cf. Donaldson, 1996, 2001). The contingency approach to management accounting is based on the premise that there is no universally appropriate MCS that applies equally to all organizations in all circumstances. Rather, it is postulated that particular features of an appropriate MCS will depend upon the specific contingencies in which an organization finds itself (cf. Otley, 1980; Fisher, 1995; Chapman, 1997; Fisher, 1998; Chenhall, 2003). Thus, a contingency theory must identify specific design attributes of MCS which are associated with certain contingency factors and demonstrate an appropriate matching or "fit". The concept of equilibrium as "fit" occurs when a combination of organizational and contextual characteristics produces higher organizational performance than alternative combinations (cf. Schoonhoven, 1981; Drazin and Van de Ven, 1985; Fry and Smith, 1987; Gresov, 1989; Venkatraman, 1989). Contingency studies assume that, although organizations must have a good "fit" to survive, and competitive pressures tend to move them toward equilibrium, disequilibrium often occurs because of individual bounded rationality and satisficing constrains. Organizational disequilibrium, or "misfit" situations, can endure for long periods as organizational inertia prevents to bring decision-making and control practices in alignment with organizational objectives (Donaldson, 2001). The identification of contextual variables potentially implicated in the design of effective MCS can be traced to the original structural contingency frameworks developed within organizational theory (Burns and Stalker, 1961; Lawrence and Lorsch, 1967; Thompson, 1967; Perrow, 1970; Galbraith, 1973). Early research in management accounting drew on this literature to examine the importance of contextual variables like environmental characteristics, organizational size and technology (cf. Waterhouse and Tiessen, 1978; Otley, 1980). Subsequently, contingency-based research focused on a variety of contingency factors to explain determinants and effects of performance measurement choice. Two strands of literature seem to have attracted most attention (Ittner and Larcker, 1998b, 2001). The first group of studies investigates the association between organizational design issues and performance measures. Early studies focused on the role of *perceived environmental uncertainty* (PEU) on the design of MCS (e.g. Hayes, 1977; Gordon and Narayanan, 1984). They were followed by a series of studies examining the association of PEU and a specific set of MCS attributes. In particular, a stream of studies stemmed from the seminal paper by Chenhall and Morris (1986) that examined the perceived *usefulness* of four management accounting system attributes: *scope* (e.g., external, non-financial, and future-oriented), *timeliness*, *integration*, and level of *aggregation* of information. They found that decentralization is associated with a preference for aggregated and integrated information, perceived environmental uncertainty with broad scope and timely information, and organizational interdependencies with broad scope, aggregated, and integrated information. Moreover, the effects of PEU and organizational interdependencies were due in part to indirect associations through decentralization. Other studies adapting the four-dimension MCS instrument by Chenhall and Morris (1986) focused instead on their association with the *importance* (Abernethy and Guthrie, 1994; Bouwens and Abernethy, 2000), the *use* (Mia and Chenhall, 1994; Chong, 1996; Chong and Chong, 1997) or the *availability* of accounting information (Gul and Chia, 1994; Chia, 1995). Taken together, this stream of literature provides evidence of differential effects on managerial attitudes (*usefulness, use* or *importance*) and knowledge (*availability*) about performance measure attributes. However, problems emerge when attempting to integrate the results of these studies because of the varying foci of the instruments used to measure these attributes, the different combination of contingency factors under investigation and, in relation to that, a substantive lack of replication studies (cf. Harrison, 2001 for a critical review on this group of studies).

The second stream of studies adopting a contingency-based approach focused on *strategy* as an important contextual variable to explain design, use and performance effects of management accounting and control systems (cf. the reviews by Langfield-Smith, 1997 and Chenhall, 2003:150 for critical commentaries on these studies). Some researchers concentrated on the strategy-MCS relationships at the *corporate* or *business-unit* level of analysis (cf. Kald, Nilsson and Rapp, 2000). Concerning performance measurement, for instance, Govindarajan and Gupta (1985) found that *build* strategy (which involve low specialization and difficulty in measuring outcomes) suited more subjective and long-term controls compared to *harvest* strategies. Simons (1987) found that successful prospector companies used a high degree of forecast data in control reports, set tight budget goals, and monitored outputs carefully, with little attention paid to cost control. Large prospectors emphasized frequent reporting and used uniform control systems that were modified frequently, while defenders used management control systems less actively. In another study, Guilding (1999) added evidence that prospector firms and firms following a build strategy made greater use of competitor assessment systems and perceived these systems to be more useful than did defender firms or those following a harvest strategy.

Other management accounting studies examined the association between lower-level *operational* or *manufacturing* strategies and performance measurement systems. Table B.1 in Appendix B provides an overview of the most representative studies in this group and summarizes their findings. A variety of advanced manufacturing practices such as total quality management (e.g. Daniel and Reitsperger, 1991; 1992; Wruck and Jensen, 1994; Daniel *et al.*, 1995; Ittner and Larcker, 1995; Chenhall, 1997; Ittner and Larcker, 1997; Van der Stede *et al.*, 2003; Chong and Rundus, 2004), just-in-time production (e.g. Banker, Potter and Schroeder, 1993; Young and Selto, 1993; Sim and Killough, 1998; Fullerton and McWatters, 2002), and flexible manufacturing systems (e.g. Abernethy and Lillis, 1995; Perera *et al.*, 1997) have been investigated in association with performance measurement design. In particular, the quality management literature advocates the benefits of using non-financial measures to track the firm's quality improvement efforts. Based on these arguments, firms focusing on a quality strategy are expected to include quality (i.e., predominantly non-financial) performance metrics to align managers' efforts with the strategic quality objectives of the firm. In general, empirical evidence from these studies confirmed that organizations following advanced manufacturing strategies are positively associated with the provision of non-financial measures and goals such as defect rates, on-time delivery, and machine utilization, as well as greater emphasis on non-financial measures in reward systems.

On the other hand, empirical proof of the link between performance measurement choices and organizational performance remains inconclusive so far. Some studies are suggestive of enhanced performance effects (Abernethy and Lillis, 1995; Chenhall, 1997; Chong and Rundus, 2004; Maiga and Jacobs, 2005), while other studies failed to find associations between the use of non-financial performance measures and organizational performance (Ittner and Larcker, 1995; Perera *et al.*, 1997; Sim and Killough, 1998). Potential problems plaguing most of these studies refer to specification of the research model, variable measurement, and reliance on cross-sectional survey-based studies (cf. Chenhall, 1999; Ittner and Larcker, 2001). The latter point in particular is problematic if researchers relying upon contingency theory aim to test fit/misfit situations (cf. Hartmann and Moers, 1999; Luft and Shields, 2002; Hartmann and Moers, 2003; Gerdin, 2005a, 2005b; Hartmann, 2005). Most of these studies also examine only one operational strategy at a time, despite evidence that many companies simultaneously adopt multiple lower-level strategies (cf. Chenhall and Langfield-Smith, 1998b). Lastly, Ittner and Larcker (2001:382) point out that prior studies examined only one or few uses of performance measures (e.g. compensation and problem identification) while ignoring other potential uses. More specifically, some studies refer to the *decision-control* role of management accounting information (e.g. Abernethy and Lillis, 1995; Chenhall, 1997; Perera *et al.*, 1997). The control (*decision-influencing*) role of management accounting should provide information that improves employees' abilities to make organizational desirable decisions, thereby enabling employees to effectively achieve the organization objectives. Sprinkle (2003:290) suggests that the decision-influencing role for managerial accounting information can be viewed as the use of information to reduce *ex-post* uncertainty discussed in Tiessen and Waterhouse (1983), the *performance evaluation* use of managerial accounting information discussed in Baiman (1990) and includes the *scorekeeping* use of information discussed in Simon, Guetzkow, Kozmetsky and Tyndall (1954). In turn, Perera *et al.* (1997) refer to the label *motivational* use of (management) accounting information. Other studies refer instead to the *decision-making* role of management accounting information (e.g. Chenhall and Morris, 1986; Bouwens and Abernethy, 2000; Davila, 2000). According to Sprinkle (2003:302), this role for managerial accounting information can be viewed as the use of information to reduce *ex ante* uncertainty discussed in Tiessen and Waterhouse (1983), the *belief revision* use of managerial accounting information discussed in Baiman (1980), and is analogous to the *problem-solving* use discussed in Simon *et al.* (1954). In turn, Perera et al. (1997) refer to the label *informational* use of (management) accounting information. The decision-making (*decision-facilitating*) role of management accounting should provide information that helps align the interests of employees with owners by directing effort and attention to activities that provide benefit the objectives of the organization. Accordingly, performance measures and control systems are expected to be used to reduce the "uncertainty gap", defined as the difference between the amount of information required to perform a task and the amount of information already possessed by the organization (Galbraith, 1973:5). Overall, as concluded by Ittner and Larcker (2001:379):

> *"This set of study generally supports theories that the choice of performance measures is a function of the organization's competitive environment, strategy and organizational design, but the performance effects of these choices remain uncertain".*

2.3.2 Economics-based research

The second group of performance measure studies looks specifically on design attributes of compensation plans. Theses studies draw on a sizeable portion of the economic literature which is devoted to understanding how organizations should design performance-based contracts (cf. Gibbons, 1998; Prendergast, 1999; Murphy, 2000; Baker, 2002; Prendergast, 2002). This literature developed around the *informativeness* principle by Holmstrom (1979), which posits that compensation contracts should include any (costless) measure that carries incremental information about the agent's actions (Lambert, 2001). According to analytical models informed by agency theory, the relative weight placed on an individual measure should be a function of three informativeness attributes: *sensitivity*, *precision* and *congruence* (Banker and Datar, 1989; Feltham and Xie, 1994; Datar, Cohen Kulp and Lambert, 2001; Baker, 2002). *Sensitivity* is defined as the marginal contribution of the manager's actions to the expected outcome of a performance measure (i.e. the change in a performance measure's mean value in response to a change in the manager's actions). *Precision* is defined as the variance in the actual outcome of the performance measure due to random events (i.e. the inverse of the variance in the measure given the manager's action). Although the concept of precision of a performance measure is specifically formulated within principal-agent analytical models, a conceptually similar construct can be intuitively associated with that of *controllability* (cf. Hirst, 1983; Merchant, 1985; Choudhury, 1986; Merchant, 1987) stemming from behavioral-based empirical research in management accounting (i.e. the greater the impact of uncontrollable events on a performance measure, the lower the controllability and therefore the less precise the same measures can be classified). Finally, *congruency* (or, taking the opposite meaning, *distortion* in Baker, 2002) refers to the alignment between the attainment of the principal's payoff and the action measured by the performance measure. Other analytical models (Hauser, Siemester and Wernefelt, 1994; Hemmer, 1996) suggest that financial performance measures alone are potentially incomplete, and that other indicators of future financial performance (i.e. non-financial performance measures) can provide incremental information on a manager's actions.

A number of cross-sectional studies draw upon informativeness and agency theoretic insights when examining the *relative* weights placed on individual, non-financial or subjective performance measures (e.g. Ittner and Larcker, 1997; Ittner, Larcker and Rajan, 1997; Ittner and Larcker, 2002a; Ittner *et al.*, 2003a; Gibbs, Merchant, Van der Stede and Vargus, 2004b). To test economics-based agency predictions, a diffused approach is to create from archival data indirect proxies for factors that are expected to affect the informativeness of individual, non-financial or subjective measures. The compensation studies in management accounting examine thus many of the same factors as the first group of papers, though with a focus on the use of performance measures for performance evaluation and to the contractual design of reward systems. For instance, operational strategies, like quality strategy in Ittner, Larcker and Rajan (1997), or research and development (R&D) strategy in Gibbs *et al.* (2004), are examined, with the weight placed on quality or R&D measures expected to be higher when the informativeness proxies are greater. The argument is that the implementation of a strategy determines the extent to which a set of performance measures is informative for the achievement of the same strategy (Ittner and Larcker, 2002a). There is mixed evidence from these studies. It is generally found that proxies for factors predicted to influence informativeness (sensitivity and precision) are associated with increased weights on these measures. However, limitations from the data forcing researchers to use proxies to measure informativeness might have compromised the significance of the analysis (Ittner *et al.*, 2003a).

While the preceding studies examine the types of performance measures used for compensation, other studies examine the organizational level at which performance criteria are measured. Bushman, Indjiejikian and Smith (1995) investigated the factors affecting the use of business unit versus corporate-level performance measures in business unit compensation plans. They found the use of corporate measures positively associated with organizational interdependencies. A similar study by Keating (1997) examined the use of division and firm-level measures for division manager performance evaluation. Significant factors in the choice of measures were divisional growth opportunities, organizational interdependencies, and the division's size relative to the size of the company. Ittner and Larcker (2002a) extended these studies to incentive plans for non-management workers. They found that informativeness issues such as those addressed in economic theories are key factors in the selection of performance measures for worker incentive plans. However, they also found that other reasons for adopting the plan (e.g., improving pay-for-performance linkages and upgrading the workforce) play a role in worker-level performance measure choices, as do union representation and management participation in plan design. Moreover, the factors influencing the use of *specific* measures (e.g., accounting, cost control, quality, safety, etc.) varied, suggesting that the aggregate performance measure classifications commonly used in compensation research, such as the comparison of financial versus non-financial metrics, provide somewhat misleading inferences regarding performance measurement choices.

A more recent stream of studies examines the interrelationships between organizational design characteristics and performance measurement systems, drawing on the "organizational architecture" framework from managerial economics. The organizational architecture of a firm consists of three crucial design variables: (1) delegation of authority, (2) use of performance measures, and (3) link between performance measures and rewards (Brickley *et al.*, 2001). The theoretical literature emphasizes that these organizational design variables are joint decision variables (cf. Melumad, Mookherjee and Reichelstein, 1992; Milgrom and Roberts, 1992; Baiman, Larcker and Rajan, 1995; Brickley *et al.*, 2001). That is, rather than separately deciding on each design variable, these variables are chosen simultaneously. An example of the studies investigating this issue is Nagar (2002) who examined the simultaneous choice of delegation and incentive compensation for branch managers in retail banks. He found that delegation positively affects incentive-based pay but, inconsistent with principal-agent theory, incentive-based pay does not affect delegation. Evidence of a simultaneous effect between decentralization and use of performance measures was found by Abernethy, Bouwens and van Lent (2004). In their study, decentralization was positively related to the level of information asymmetries and negatively related to intra-firm interdependencies, while the use of performance measures was affected by the level of interdependencies among divisions within the firm, but not by information asymmetries.

With regard to empirical evidence about performance effects, none of the straight compensation studies of this group examines performance consequences. However, related behavioral-based research suggests that organizations that align their incentive plans' performance measures with contingency factors such as those discussed in Section 2.3.1 achieve higher performance. Early studies, like Simons (1987) and Govindarajan (1988) found higher performance in organizations following defender or low cost strategies when bonuses are awarded for the achievement of budget targets. Similarly, Govindarajan and Gupta (1985) found that greater reliance on non-financial compensation criteria (sales growth, market share, new product and market development, and political/public affairs) had a stronger positive impact in units following a build strategy than in those following a harvest strategy. As a final point, some studies investigate the ability of non-financial performance measures to predict future financial measures. By documenting a positive association between current non-financial measures and future financial measures, these studies imply that non-financial measures should be relevant leading indicators to investors and creditors whose decisions are based on their expectations of future realizations of financial measures (e.g. Ittner and Larcker, 1998a; Banker, Lee, Potter and Srinivasan, 2000; Banker, Potter and Srinivasan, 2000; Nagar and Rajan, 2001; Said, HassabElnaby and Wier, 2003). Interestingly, the focus of this group of papers is similar to the literature that analyzed the CSP-CFP relationship in environmental management and accounting literature that was reviewed in Section 2.2.7.

2.4 Evaluation and directions of research in this study

Several conclusions can be drawn from extant literature in management accounting about performance measurement choice. First, it appears from the overview presented here that management accounting employs a rich variety of theoretical frameworks that are informed by different social sciences (primarily sociology, psychology and economics). Each perspective makes different choices about assumptions, variables investigated and causal-model form, while holding constant, or disregarding, other potentially important issues. As a result, recent commentaries about the state-of-the-art in management accounting research emphasize a divide in the empirical management accounting literature (cf. Zimmerman, 2001 and Merchant *et al.* 2003). Noting this problem in the empirical literature that studied organizational incentives, Merchant *et al.* (2003:251) sharply criticize the extant chasm between disciplines:

> *"Many researchers seem to lock quickly into a single research discipline, paradigm or theory and ignore developments and insights from other fields, that could shed light on the research issue on which they are focusing. These narrow, single discipline- or paradigm bound foci have hindered research progress by fragmenting the literature, by hindering communication (because of the concurrent use of highly specialized jargon with quite similar meaning), and by suggesting incomplete, and in some cases, incorrect conclusions".*

In order to overcome the current divide, many suggest in alternative to adopt an integrative research approach to provide more complete theory-driven understanding of the management accounting-related phenomenon under investigation (Ittner and Larcker, 2001; Hopwood, 2002; Ittner and Larcker, 2002b; Covaleski *et al.*, 2003; Luft and Shields, 2003). In particular, a research strategy that would combine economics-based and behavioral approaches, as opposed to fixating on a purely economic model (cf. Zimmerman, 2001), is argued to be more likely to produce substantive insights about managerial accounting.

Concerning the behavioral-based studies summarized before, in general support was found to theories claiming that the choice of action plans and performance measures needs to be contingent on organizational characteristics. However, several shortcomings are associated with these studies (cf. Ittner and Larcker, 2001:382). First, each study tends to examine only one or a few uses of performance measures (e.g., compensation or capital justification), while ignoring other potential uses (e.g., planning and problem identification) that may be equally or more important to firm's success. Second, the studies overlook the properties or "quality" of information used for decision-making and control (among others, dimensions of accessibility, timeliness, reliability and understanding of information), even though information system characteristics are likely to influence decision-making quality and the incentive effects of control systems. Moreover, the distinction between *design* and *use* of management control and performance measurement is unclear or not explicitly addressed in most of the studies in this area (Langfield-Smith, 1997). Prior research on performance measurement system innovations indicates that technical and organizational factors can play an important role in the perceived success and use of management accounting system implementation (e.g. Shields, 1995; Anderson and Young, 1999; Cavalluzzo and Ittner, 2004). Future studies can make a significant contribution by examining how these factors interact with system design choices to influence actual use and performance measurement outcomes. In particular, it appears that *strategy*-MCS relationship is still an under-researched topic in management accounting and control (Dent, 1990; Langfield-Smith, 1997; Fisher, 1998; Kald *et al.*, 2000; Van der Stede *et al.*, 2003). According to Kald and Rapp (2001), not many studies examined in detail both the design and use of performance measurement in relation to the business strategy pursued. The effect of specific functional strategies on the design of management accounting and control systems has been proposed in past accounting research as a critical issue that has not received adequate research attention.

Moreover, external factors can be expected to influence extent and manner to which performance measurement systems are used within organizations. Previous studies have only preliminarily investigated the consistency in performance measures used internally for different purposes or the alignment between the use of the same measures for internal planning/control and external reporting, despite claims that performance is enhanced when measurement systems are aligned with internal and external critical success factors (cf. Epstein and Birchard, 1999; Eccles *et al.*, 2001). Provided that the boundaries between managerial and financial accounting are increasingly fictitious, empirical evidence regarding the linkages between the two areas remains undernourished. While some recent results emerged in performance measurement studies in the public sector (e.g. Geiger and Ittner, 1996; Eggleton, Silalahi and Chong, 2001; Modell, 2001; Cavalluzzo and Ittner, 2004), more research is needed in for-profit sectors on this issue (cf. Joseph, Turley, Burns, Lewis, Scapens and Southworth, 1996)

Based on these discussions about management accounting research on performance measurement choice and taking into account the scant literature in (positivist) environmental accounting literature, this dissertation represents one of the first empirical studies in environmental management accounting. Despite anecdotal evidence about the increased diffusion of environmental-related performance measurement systems, relatively little is known about driving factors and consequences associated with these "innovative" MCS. Consequently, following the research questions proposed in Chapter 1, in the remainder of the dissertation I will explore design attributes and use of environmental performance measures by drawing on mainstream research in management accounting. In particular, I develop three directions of further investigation, also in the attempt to contribute to the limitations of extant research mentioned above.

First, following the discussion about the paradigmatic divide that characterizes the literature, I will investigate the use of environmental performance measures by integrating behavioral- and economics-based research streams. The attempt is to identify the most relevant explanatory variables of performance measurement choice from both groups of studies and to empirically test the explanatory power of a combined approach rather than in isolation. As a related issue, I will also argue in the next chapter about the need to move forward the usual dichotomy financial versus non-financial performance measures (*practice-defined variable* in Luft and Shields, 2003:188), and focusing instead on more specific underlying management accounting systems attributes and performance measure properties (*theory-defined variable* in Luft and Shields, 2003:188). Recent examples pointing in this direction are Ittner *et al.* (2003a), Ittner, Larcker and Randall (2003b), Van der Stede *et al.* (2003), Abernethy *et al.* (2004), Cavalluzzo and Ittner (2004), Gibbs *et al.* (2004b; 2004a) and Malina and Selto (2004).

Second, after having examined the contingency-based literature, I will explore the role of *strategy* as main explanatory factor of performance measurement choice. The discussion presented in Section 2.2.1 about the analogies between environmental strategy and quality strategy reveals fruitful avenues of research.

Third, I will extend current behavioral-research by exploring extent, manner and consistency of use in the attempt to explain the differential use of management accounting information for internal decision-making and control *versus* external accountability. In this respect, the study contributes to our knowledge regarding the use of performance measures in function of different purposes as a topic of research suggested by recent articles (Ittner *et al.*, 2003b; Abernethy and Vagnoni, 2004).

2.5 Summary

This chapter presented a review and evaluation of the literature in environmental management and environmental accounting. First of all, it can be concluded that extant research about this topic has not entered yet a mature phase in terms of having established sound conceptual foundations and empirical findings. Within the research in the accounting field, a sizeable portion of the empirical literature classifiable with the label of environmental and social accounting research has adopted a financial accounting perspective, particularly because data from corporate environmental reports and environmental disclosures has increasingly become more accessible. At the same time, and typical of any novel field of investigation, empirical evidence accumulated in the multidisciplinary area around environmental management has provided a fragmented body of knowledge. I emphasized therefore the need to concentrate the research focus for this study on intra-organizational aspects of environmental management. In particular, performance measurement and control systems are objects of limited analysis in the area of environmental management but the practitioners' literature emphasizes the increased relevance of these systems. In this respect, I argued that it could be fruitful to draw upon the literature in mainstream management accounting and control that examined design and use attributes of performance measurement systems. Given the paucity of the literature that focused on environmental performance measures, the approach that logically follows in this study is to adapt extant theories and findings from the more established area of management accounting research. I also argued that many of the theoretical issues and empirical developments about environmental-related performance measurement are not unique but would inform a broader debate over performance measurement choice. In particular, three research directions have been introduced and will be elaborated upon in Chapter 3 to develop a set of testable hypotheses.

Endnotes Chapter 2

[1] Refer to Kolk and Mauser (2000:22-23) for a discussion about the difference between a *continuum* typical of a stage model and a *typology*. Following Doty and Glick (1994), they argue that a *continuum* consists of a linear classification scheme that identifies a development over time, whereas a *typology* consists of conceptually derived interrelated sets of ideal types. Concerning environmental management, typologies are generally much more flexible than continuum models. In fact, the generally accepted idea of a growing environmental performance (effectiveness), on which continuum models are based, does not hold for typologies. It can be inferred from their remarks that continuum models integrate the concept of fit in contingency-based research (cf. Fry and Smith, 1987; Venkatraman, 1989; Van de Ven and Poole, 1995; Donaldson, 1996, 2001) between environmental management and environmental performance, given that companies situated along the ideal stage types differ in their effectiveness to manage their impact on the natural environment. Models relying upon typologies do not require the latter condition.

[2] *Convergent* validity means that evidence from different sources gathered in different ways all indicate the same or similar meaning of the construct. *Discriminant* validity means that researchers can empirically differentiate the construct from other constructs that may be similar and point out what is unrelated to the construct (Kerlinger and Lee, 2000).

[3] The GRI incorporates the active participation of representatives from business, accountancy, investment, environmental, human rights, and labour organizations from around the world. Started in 1997, GRI became independent in 2002, and is an official collaborating centre of the United Nations Environment Programme (UNEP).

[4] The initiative aims to provide a medium through which those interested can contact other research and practitioners with similar interests, and to organize regular events for the dissemination and exchange of information and ideas. The dissemination of EMA occurs primarily through the Internet (Environmental Management Accounting Research & Information Center - EMARIC).

[5] The selection of the articles has been manually performed using digital search engines available through the Dutch library systems (among them, EBSCO, ScienceDirect, ABI/INFORM, Blackwell, and Ingenta contain complete collections of international academic publications).

[6] Recent studies address the determinants of environmental management at the individual level of analysis drawing upon organizational behavior and psychology theories (e.g. Bazerman *et al.*, 1997; Bazerman and Hoffman, 1999; Flannery and May, 2000; Sharma, 2000; Bansal, 2003).

[7] The “critical school” of social and environmental accounting relied upon alternative theoretical frameworks to explain adoption of environmental reporting and disclosure practices. Among them, for example, Marxian political economy theory (e.g. Tinker *et al.*, 1991), modern communitarianism (Lehman, 1999), and Gidden’s structuration theory (e.g. Buhr, 2002).

[8] At the individual level of analysis, the field of environmental management starts to be explored by researchers that apply psychological theories. An emerging group of studies published in management journals analyze psychological mechanisms behind environmental management. Among them, some researchers address the "attitude/behavior gap" identified in prior research between environmental protection intentions and actual behavior (Bazerman *et al.*, 1997). In this respect, Ajzen's *planned behavior theory* was employed to examine how personal characteristics of individual managers are associated with different attitudes and behavior in the context of environmental decision-making (Cordano and Hanson Frieze, 2000; Flannery and May, 2000). Other researchers applied instead *prospect theory* (cf. Kahneman and Tversky, 1979) to examine whether managers perceive environmental issues as a threat or an opportunity that is likely to shape their decision-making and the formulation of environmental strategy (Sharma, 2000; Tenbrunsel, Wade-Benzoni, Messick and Bazerman, 2000).

[9] CSP can be defined as *"a business organization's configuration of social responsiveness, and policies, programs, and observable outcomes as they relate to the firm's societal relationships"* (Wood, 2000).

[10] Orlitzky *et al.* (2003:410-411) claimed that the vote-counting method used by, among others, Margolis and Walsh (2003) tends to draw false inferences because it does not correct for sampling and measurement error (i.e. unreliability). They further argued that prior literature reviews using vote-counting approach do not correctly rely on a binary world-view, holding that a relationship between CSP and CFP either exist (if results are statistically positive, or negative) or does not exist (if results are mixed or statistically non-significant). In fact, effect-size (r) meta-analysis is a rigorous approach to external validation, which calculates population parameter estimates (ρ) by correcting for sampling and measurement error.

[11] Refer to Van den Brink (2002) for a review of rating and monitoring criteria used by 28 international specialized rating agencies to assess corporate sustainability profiles.

[12] The Social Responsible Studies research website (http://www.sristudies.org) provides an exhaustive and continuously updated list of summarized articles covering this topic.

[13] The study ignored how the waste minimization program affected plant and division manager evaluation and compensation because the researcher did not get access to the data. The study confirms how the research developments in the area are currently hampered by inaccessibility of data about internal practices of environmental management and environmental accounting.

CHAPTER 3
HYPOTHESIS DEVELOPMENT

3.1 Introduction

Based on the discussion from the extant literature in environmental management, environmental accounting and management accounting presented in Chapter 2, the present chapter develops theoretical propositions about determinants and performance effects of environmental performance measurement systems. These propositions address the first two research questions elaborated at the outset of the dissertation:

RQ1a *What factors explain the use of environmental performance measures in management control systems?*

RQ1b *Is there consistency between the information that is disclosed externally and the environmental performance measures that are used internally for planning and control?*

RQ2 *Is environmental performance enhanced by the fit between environmental strategy and the use of environmental performance measures?*

The third research question concerning the processual aspects of performance measurement change will be addressed in Chapter 6 using the evidence of a longitudinal field study.

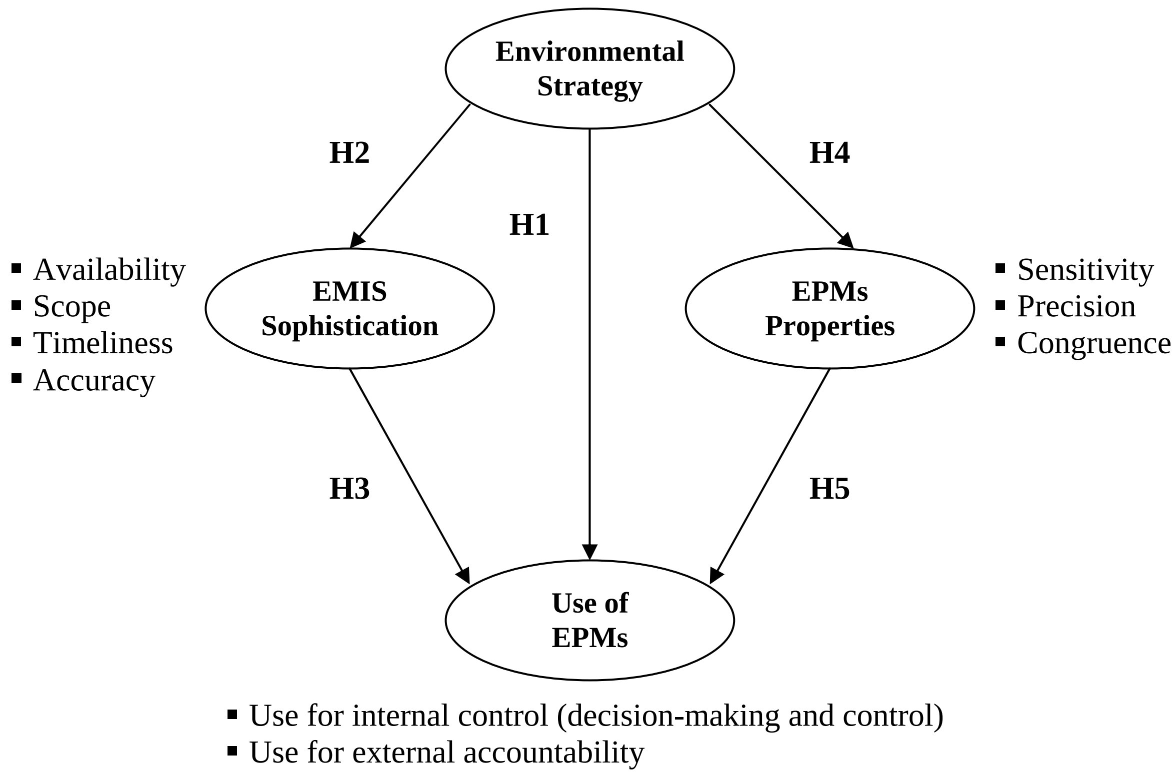
The chapter is structured as follows. In the first part of the chapter, I will concentrate on the determinants of design and use of environmental performance measures. In Section 3.2 I develop a conceptual model that explores determinants of the use of environmental performance measures in management control systems. The objective is to examine some of the multiple contingencies that explain extent and manner of use of environmental performance measures within a complex nomological network. First, in Section 3.2.1 I will define the constructs object of study and motivate their relevance from prior research as it emerged from the previous chapter. Then, Section 3.2.2 develops exploratory hypotheses concerning the relationships addressed in the conceptual model. In the second part of the chapter, the focus will be on the performance effects associated with the use of environmental performance measures. Section 3.3 defines the construct of environmental performance used in this study and specifies the theoretical framework to explain environmental performance consequences of environmental strategy in combination with environmental performance measurement systems. At the end of the chapter, Section 3.4 presents an overview of the hypotheses.

3.2 Determinants of environmental performance measurement systems design and use

3.2.1 Conceptual framework and definition of constructs

Drawing upon extant literature that focused on design and use of performance measurement systems in management accounting research, in this section I develop a conceptual model of performance measurement choice that is adapted to the context of environmental management. Figure 3.1 outlines the proposed research model and the relationships among variables.

Figure 3.1 – The conceptual model about determinants of EPMs use



The model attempts to gain initial insights about the factors that explain design and use of environmental performance measures by bringing together constructs from different literatures that were reviewed in the previous chapter. Specifically, I develop a nomological network[1] that examines the linkages among variables concerning environmental strategy implementation, specific informational attributes of environmental management information system and use of environmental performance measures. Hypotheses are developed concerning a set of theoretical paths that build upon contingency-based as well as economics-based studies in management accounting research. The model examines the determinants of performance measurement choice in the specific setting of environmental management, although it could be potentially applicable to other contexts where the focus is not centred on environmental-related performance measures.

Concerning the underlying rationale of the model, it is posited as a general expectation that the environmental strategy implemented in organizations *directly* affects the use of environmental performance measures. As the hypothesis development section further elaborates, it can be anticipated that a company' strategic approach towards the natural environment affects the extent to which it relies upon environmental performance measures for planning and control. This argument is consistent with empirical findings in management accounting literature that provide evidence of a "fit" or match between features of MCS and specific aspects of a business strategy (cf. Fisher, 1995; Langfield-Smith, 1997; Chenhall, 2003). In addition, the model contends that the extent of use of environmental performance measures depends upon some informational or design characteristics associated with the environmental performance measurement system. In support of this argument, I rely upon the line of reasoning proposed by Gul (1991), according to which availability and usefulness of information are prerequisites (amongst others) for its use:

> *"Useful MCS information should be available (or available information should be useful) before it can have a meaningful relationship with performance"*.

In a similar vein, Simons (2000:208) underlines the importance of the distinction between design and use of management accounting information by referring to *diagnostic* versus *interactive* style of management control systems:

> *"The difference between diagnostic and interactive control systems is not in their technical design features. A diagnostic control system may look identical to an interactive control system. The distinction between the two is solely in the way that managers use these systems"*.

The central premise of the model thus is that strategic choice regarding environmental-related aspects of business (*environmental strategy*) affects the use of performance measures *indirectly* through intervening variables that capture informational characteristics of management accounting systems.

Table 3.1 – Variables investigated and definitions for this study

Variable	***Definition***	***Literature of reference***
Environmental strategy	Intensity of environmental management principles and practices implemented in an organization (typology of companies *reactive* → *proactive*).	Environmental management/Operations management
Sophistication of environmental information system:		
Availability	Extent to which quantity and variety of environmental performance measures are generated and internally reported by a company's management information system.	Management accounting (contingency-based research)
Scope	Extent to which environmental performance metrics are focused on both internal and external dimensions of environmental performance (*narrow* → *broad scope* EMIS).	Management accounting (contingency-based research)
Timeliness	Frequency and speed of systematic reporting about environmental-related information.	Management accounting (contingency-based research)
Accuracy	A combination of verifiability and objectivity of performance measures. *Verifiability* assumes that independent measurers can duplicate the performance measures by using the same measurement methods. *Objectivity* denotes that the measurement is "free from personal bias".	Management accounting (contingency-based research)
Informativeness of environmental performance measures:		
Congruity	Degree of congruence between the impact of an agent's action on environmental performance measures and on the principal's payoff measured in terms of financial performance.	Management accounting (economics-based research)
Sensitivity	Extent to which an agent's action has a large expected effect on environmental performance measures.	Management accounting (economics-based research)
Precision	The proportion of the variation in environmental performance measures explained by an agent's actions.	Management accounting (economics-based research)
Use of environmental performance measures:		
Internal use for decision-making and control	Extent to which environmental performance measures are used within an organization for both decision-making and decision-control purposes.	Management accounting (contingency-based research)
External use for accountability	Extent to which environmental performance measures are used to gain legitimacy towards external constituencies (shareholders, stakeholders, local communities, NGO's, public opinion)	Management accounting (contingency-based research)

Table 3.1 (continued)

Variable	*Definition*	*Literature of reference*
Consistency of use of environmental performance measures	Difference (or "gap") between the use of environmental performance measures for internal control and the use of environmental performance measures for external accountability.	Management accounting (notion of "measurement gap" in Ittner and Larcker, 2001) Environmental management (notion of "greenwashing" in Laufer, 2003)
Environmental performance	Multidimensional construct that reflects the impact of business activities on the natural environment.	Environmental management/Operations management

In this study, these intervening variables are identified respectively under the labels of *sophistication of environmental management information system* (*EMIS)* and *properties of environmental performance measures* (*EPMs)*.

The first group of constructs refers to informational design attributes inherent to management accounting and management information systems that were developed within a stream of studies examining use and effects of MCS design under different contingency factors (see Chenhall, 2003 for a review). I refer to the overview of these studies described in Section 2.3.1 stemming from the seminal article by Chenhall and Morris (1986).The second cluster of constructs refers to properties of performance measures as proposed in economics-based studies that apply agency theory in empirical accounting research about managerial compensation and performance evaluation (cf. Indjejikian, 1999; Lambert, 2001; Baker, 2002). These performance measures properties were introduced and discussed in Section 2.3.2. In the following sections a definition of each variable is presented in more detail and discussed in relation with prior literature(s). Table 3.1 summarizes the definitions of the constructs and the literature of reference.

Environmental strategy

In Section 2.2.1, I provided an overview of the most representative definitions and instruments about environmental management configurations that were examined over the last years from different academic disciplines. At the conceptual level, the sparse literature available presents a variety of theoretical constructs concerning environmental management practices. At the empirical level, the proliferation of studies from various academic disciplines has generated a plethora of measurement instruments, which widely differ in terms of content and level of analysis. In this study, *environmental strategy* can be regarded as an overall construct which comprises management philosophies embodied in practices and programs used to integrate environmental issues in business strategies and operations. Among the definitions available from extant literature, the term of *corporate environmental orientation* by Banerjee (2002a:181) captures the construct fairly well:

> *"Corporate environmentalism is the organization-wide recognition of the legitimacy and importance of the biophysical environment in the formulation of organization strategy, and the integration of environmental issues into the strategic process".*

In line with most recent attempts to define the construct, *environmental strategy* thus intends to signify the intensity of environmental management principles and practices implemented in an organization. The construct can be empirically measured along a continuum where at one extreme environmental strategy is not yet developed and integrated in traditional business strategy (so-called- environmentally *reactive* companies) in contrast with the other extreme where companies have devised an environmental strategy which is aligned with their current policies and management practices (so-called environmentally *proactive* companies). The choice of using this typology of environmental management intensity has the advantage of allowing a comprehensive classification of corporate strategic positioning towards the natural environment, in full alignment with recent developments in the environmental management literature. The broad definition of *environmental strategy* is particularly suitable for the exploratory research approach developed for this study.

Concerning the model specification, I expect to empirically observe cross-sectional variation in companies' degree of proactive environmental strategy. The model does not set forth to explain this variation, primarily because I argued in Section 2.2.4 that the body of knowledge empirically available from extant literature about the drivers of environmental management is fairly established to reach some generalizable conclusions. Rather, in the present study I treat *environmental strategy* as an exogenous variable without extending the analysis to its conceptual antecedents. This would require the development of an enlarged nomological network. The vast majority of prior empirical research in management accounting has modeled the linkages between strategy and MCS characteristics by adopting similar nomological nets when examining operational strategies like TQM, JIT or flexible manufacturing (e.g. Abernethy and Lillis, 1995; Ittner and Larcker, 1995; Chenhall, 1997; Perera *et al.*, 1997; Davila, 2000; Van der Stede *et al.*, 2003). I anticipate here a limitation associated to the treatment of *environmental strategy* as an exogenous variable, while expecting that the variable is likely to be endogenously determined by contextual or organizational factors that are not addressed in the conceptual model.[2] However, I opt for a parsimonious model specification given the exploratory phase of the research. A further elaboration on this issue will be discussed when I will address the limitations of the study in Chapter 5.

In sum, *environmental strategy* reflects the intensity of environmental management principles and practices of an organization. The construct is treated as a continuum typology where organizations can be classified, at its extreme, as either *reactive* or *proactive* vis-à-vis their approach towards environmental management. In this study, this variable is posited as a theoretically relevant predictor of the use of environmental performance measures and treated as an exogenous explanatory factor in the conceptual model. Given the exploratory phase of the research, I will address this variable at both organizational and sub-unit level of analysis (Luft and Shields, 2003).

Sophistication of environmental information system

In this study, I refer to *environmental management information system* (EMIS) as a collection of *environmental performance measures* (EPMs) that are formally and systematically reported through an organization's management information system. The terms *management information system, management accounting system* and *management control systems* are used interchangeably here. In addition, the terms performance measure and performance metrics are used interchangeably to signify quantitative or qualitative information about environmental performance.[3] Alike a management information system that serves accounting and control purposes (Simons, 2000), an EMIS can be defined as a formalized information system used by organizations to influence the behavior of managers and to lead to the attainment of organizational objectives that are environmental-related. The label *sophistication of EMIS* comprises a set of attributes that pertains to design and quality characteristics of EMIS considered relevant from extant literature in contingency-based research in management accounting and control. The label is the analog concept developed by Chia (1995) in which MCS sophistication consists of four information characteristics (namely broad scope, aggregation, integration and timeliness) derived from the seminal study by Chenhall and Morris (1986). In contrast, four dimensions or design elements regarding an environmental management information system are conceptualized in this study. First, I identify in the variable *availability* a critical element capturing the extent to which quantity and variety of EPMs are generated and internally reported by a company's management information system. In the context of environmental management, this variable can be considered as a necessary condition for ensuring the use of EPMs as emphasized in a discussion that distinguishes use and availability of management accounting systems in Gul and Chia (1994:415) and in Chia (1995:815):

> *"What is perceived as useful MCS information may not be what is available from the MCS to the user".*

Accordingly, in this study, it is reasonable to describe the EMIS in terms of the system and the information that is *actually* supplied to managers, because, after all, only environmental-related information that is available can help managers to achieve environmental-related goals in their organizations. A similar argument was developed in Cavalluzzo and Ittner (2004), as they identified and measured a construct similar to *availability* under the label *measurement system development* to capture the extent to which governmental agencies developed different types of results-oriented performance measures. Examples of recent empirical studies that examine the availability of specific typologies of performance measures are Davila (2000), Ittner and Larcker (2002a), Nilsson and Kald (2002), Ittner, Larcker and Randall (2003b) and Van der Stede *et al.* (2003). Empirically, I anticipate that variation exists in the availability of EPMs, provided that some organizations are arguably more advanced in terms of their organizational capabilities to generate environmental-related information. Differences among companies about the current development of EMIS have been recently highlighted in practitioners' literature without addressing the conceptual aspects that differentiate information systems' sophistication (cf. Richards, Allenby and Compton, 2001). In this study, I will refer to the availability of EPMs by focusing on metrics expressed in *non-financial* terms because it can be expected that environmental performance metrics are appropriately captured in physical or quantitative terms. At the same time, the study is also concerned about the financial aspects of environmental performance. Thus, I further attempt to capture the availability of EPMs that are expressed in *financial* terms. The distinction is relevant particularly to understand whether difference is empirically found between non-financial and financial performance measurement in the area of environmental management. Such a distinction is rooted in recent classificatory models proposed in environmental management accounting, where physical or ecological accounting systems are distinguished from purely monetary accounting systems (cf. Schaltegger and Burritt, 2000; United Nations, 2001; IFAC, 2004).

Furthermore, I propose to investigate the sophistication of the EMIS focusing on two interrelated information system characteristics that have been previously examined in management accounting research (Chenhall and Morris, 1986; Abernethy and Guthrie, 1994; Chia, 1995; Chong and Chong, 1997; Bouwens and Abernethy, 2000; Harrison, 2001; Chenhall, 2003). First, I examine the variable *broad scope* of EMIS, defined in this study as the extent to which environmental performance metrics are focused on both internal and external dimensions of environmental performance (cf. Pondeville, 2003). An EMIS broad in scope is expected to provide managers with environmental-related information about environmental-related performance that extends beyond the boundaries of the organization. Additionally, a broad scope EMIS reflects past or future events that might affect environmental performance of the organization. Second, I address the attribute of *timeliness* which features the attributes of an EMIS to generate and internally report environmental-related information (Chenhall and Morris, 1986). Timeliness is specified here in terms of frequency and speed of systematic reporting about environmental-related information. These dimensions of an EMIS are expected to be particularly critical to ensure a prompt reaction to environmental accidents or for preventive actions to eliminate/reduce environmental risks.

When attempting to extend empirical research in any area, it is crucial to keep a concept and its associated operational instrument constant over time to allow replication. However, it is also important that the variables used reflect emerging attributes. Therefore, it was decided to include an additional EMIS attribute – *accuracy* – as its relevance in the empirical field is particularly crucial. As was discussed in Section 2.2.1, current developments in the area of environmental performance measurement and reporting appear in general not to ensure a high reliability of the metrics. The argument often discussed in practice refers to a lack of standardization and homogenous measurement methods that still impede the objective collection and comparison of these types of data. In this study the *accuracy* of performance measures is consistent with the concept defined by Merchant (1989) as a combination of verifiability and objectivity of performance measures. Verifiability assumes that independent measurers can duplicate the performance measures by using the same measurement methods (Merchant, 1989). Objectivity denotes that the measurement is "free from personal bias" (Merchant, 1989) and enhances the reliability of the measures. Ijiri (1966) long ago re-established the theoretical importance of (accounting) performance measure accuracy and objectivity (cf. also Ashton, 1977; Gibbs *et al.*, 2004a). The attention to this characteristic has been object of limited attention in management accounting and control (Gibbs *et al.*, 2004b). Overall, in this study this attribute reflects the extent to which the EPMs that are generated by the EMIS provide valid and reliable information about the environmental impact of business operations. This attribute examines the absence of manipulability of the performance measures as it was investigated in prior literature over performance measurement choice rooted in agency theoretic models (see paper by Gibbs *et al.*, 2004).

To recap, in this study EMIS sophistication is comprised of four attributes or dimensions related to a management information system that is tailored to environmental management purposes: *availability*, *scope*, *timeliness* and *accuracy* refer to the measurement technologies that companies devise to generate environmental performance measures. In line with prior research in management accounting about MCS design, I propose that a management information system with a high emphasis on each of these attributes can be considered as more sophisticated than in situation where these dimensions are less important.

Properties of environmental performance measures

Whereas the variables examined under the comprehensive label of *EMIS sophistication* intend to capture key features of an information system to ensure *reliable* environmental performance measures, additional properties can be addressed referring to the *relevance* of the performance measures. These properties are analogous to the ones analyzed in the economics-based strand of management accounting literature about performance measurement choice drawing upon principal-agent models (refer to Section 2.3.2 for an overview of this literature). In this part, I extend the insights from the literature review in Chapter 2 to explain why some specific properties associated with environmental performance measures might affect their actual use for internal decision-making and control. The explanation of these properties makes this part quite lengthy if compared to the definitions provided for the other variables.

Recent attempts to apply economics-based theory to environmental management are available from a small number of articles published in the environmental economics literature (Gabel and Sinclair-Desgagné, 1993; Sinclair-Desgagné and Gabel, 1997; Lothe, Myrtveit and Trapani, 1999; Gabel and Sinclair-Desgagné, 2001; Goldsmith and Basak, 2001; Lothe and Myrtveit, 2003). These studies conceptually treat the misallocation of environmental resources that occur within organizations analogously to the existence of negative externalities in the context of market-mediated transactions. As Gabel and Sinclair-Desgagné note (1993:229):

> *"Just as public policy tools like Pigouvian taxes, rules of civil liability, and marketable property rights might remedy market failures, there are corporate policy that might alleviate organizational failures (i.e. systematic deviation from the common assumption that firms behave as unitary and rational personae fictae)"*.

This literature suggests that the solutions to the internalization problem in the context of environmental externalities are complicated by the high uncertainty with respect to measuring negative externalities (which can be equated in this area with pollution or any harmful environmental effect). Another impediment is given by the presence of moral hazard (*hidden action*) associated with the principal's inability to monitor managerial effort towards environmental protection (Xepapadeas, 1997). On this issue, Goldsmith and Basak argue that (2001:260):

> *"While markets, both internal and external, are well established, providing signals as to the production level and optimal input mix for goods (commodities, i.e. goods with a positive price in the market) for the firm, the market for discommodities is uncertain at best. The implication is that while strategy for commodity production is commonplace, the strategy for discommodity minimization is much less clear"*.

In order to address the problem of effective managerial remedies in presence of environmental externalities within firms, the environmental economics literature employs a principal-agent framework to investigate the role of monetary incentives to support the implementation of a corporate environmental strategy.[4] The assumption underlying the studies is that (Sinclair-Desgagné and Gabel, 1997:337):

> *"…increased environmental awareness on the part of shareholders and corporate board members will not change the firm's environmental record in a significant and durable way unless it is translated into concrete amendments of the existing managerial control system"*.[5]

The underlying argument is that the lack of well-specified environmental goals leads to what is known as "the folly of rewarding A while expecting B" (Kerr, 1975) by producing a mismatch between what management cares about and what managers are actually rewarded for. Following the neo-classical economic paradigm, the literature in environmental economics assumes therefore that principals need to design compensation contracts rewarding efforts to maximize profits. A similar argument is advanced by practitioners' literature in management accounting about the necessary modification of compensation and reward systems to allow the integration of environmental issues into "traditional" business activities (e.g. Epstein and Wisner, 2001; Kaplan and Norton, 2003 and refer to the discussion on the 'sustainable balanced scorecard' in Section 2.2.2). To complicate the analysis in this setting, however, it can be expected that when a firm introduces an environmental strategy in addition to the already existing business strategy, it may fail to recognize that the effort devoted to creating profit might not be correlated to the effort necessary to achieve the environmental strategy targets. This is a classic situation of multi-tasking (Holstrom and Milgrom, 1991). To simplify with an example, devoting effort to manufacture a product with less polluting impact might be in direct conflict with devoting effort to manufacture the product at competitive costs. In this situation, one way to change managerial compensation scheme would be to modify the incentive design and introduce performance measures correlated with each specific effort required; this would mean that environmental performance measures should be included in addition to other financial and non-financial performance measures. In case suitable EPMs are not available, Holmstrom and Milgrom (1991) show that a fixed wage sometimes is more efficient than incentive-based compensation. In presence of a fixed wage, the incentives in the direction of the "easy to measure, easy to reward" activity are reduced, and more effort is therefore devoted to the other "hard to measure" activity. This solution is posited to be less efficient than an optimal incentive-based solution that rewards both tasks as a function of effort. However, a fixed wage might be the only feasible solution if profit-oriented incentives attract effort away for the environmental risk reduction activities.

A few analytical papers have tackled the issue of appropriate compensation and rewards design in the environmental management field. Gabel and Sinclair-Desgagné (1993) were the first to address the contractual aspects of managerial incentives to cope with the agency problems that potentially emerge with environmental-related decisions. They assume that top management aims at reducing environmental emissions or the possibility of an environmental accident, but the delegation of tasks and discretion to subordinates makes actual compliance uncertain. The research question they address is how should a CEO link managerial compensation to performance with respect to environmental risk reduction. They present a multi-task principal-agent analytical model to assess the relevance of incentive pay linked to performance on environmental risk reduction. Their model assumes that 1) the agent (i.e. the manager) does not have one but two tasks to perform, related either to the "standard" task of enhancing the expected profit in conflict with the objective to reduce environmental risks; and, 2) the agent has limited amount of effort to split between the two tasks. Furthermore, it is posited that the principal cannot perfectly observe the amount of effort managers would allocate to the various tasks. One main result presented in the article was that monetary incentives should become stronger, as the principal becomes more eager to promote environmental risk-reducing activities relative to activities that enhance profit and as the monitoring technology concerning environmental risks reduction becomes relatively more accurate. However, when total managerial effort reaches its peak, it might no longer be appropriate to make salaries vary with the observed reduction of environmental risk. Under these conditions, variable performance should only be based on financial performance measures. In a subsequent paper, Sinclair-Desgagné and Gabel (1997) continued this line of research by focusing on optimal incentive structure in presence of environmental audits, i.e. a formalized practice aiming at formally controlling the appropriate functioning of environmental management systems. The analytical results prove that optimal wages after the introduction of an environmental audit should have a greater range than salaries paid when no audit has occurred. A second implication is that in this context the agent's allocation of effort is essentially determined by whether his prudence[6] is stronger or weaker than his aversion to risk. For instance, when prudence dominates, it is better to run an environmental audit if current profits are high and to offer the agent a larger expected salary each time an audit takes place.

Other analytical papers built upon these early studies but concentrated on the design of environmental performance measures in compensation and incentive systems. Goldsmith and Basak (2001) identify five limitations in the measurement of EPMs that are likely to increase the complexity to appropriately design incentive contracts in this area. First, since pollution is a *dynamic problem*, products, production processes and their associated pollutants change continuously, requiring metrics that can adapt to these changes. In addition, the cumulative effects of pollutants may only be observed over long periods of time. For instances, traces of pollutant amounts barely observable today may persist and build up, causing significant environmental damage over the long run. Second, *hidden hazards* are involved. The lack of observability for some pollutants, due either to improper auditing or to technological limitations of pollution measurement tools can make EPMs less reliable measures of "true" environmental stewardship. Third, the *subjectivity* of the EPMs scores remains problematic. Choices governing which pollutant or waste is to be tracked are influenced by various factors, such as the cost of sampling (i.e. cheaper and less precise sampling procedures may be chosen), current legal requirements depending upon regulatory schemes differently enforced by governments, the environmental staff's current knowledge about environmental risk assessment, and stakeholders' expectations. Fourth, there is a problem of *data aggregation*. An environmental performance measure consists of a series of measures collected over time about the firm's level of eco-efficiency, concerning thus air emissions (e.g. tons of carbon dioxide), waste production and disposal, spills and other environmental accidents, and so forth. These environmental indicators tend to be aggregated into a single index or score and therefore may not give a clear or direct indication of the relationship between managerial effort and environmental performance. Moreover, some data, such as number of spills, do not provide an appropriate signal of environmental quality as they may vary in terms of toxicity for human beings, animals or plants. Finally, Goldsmith and Basak (2001) point out the problem of *stochastic environmental events* which is linked to the role of uncertainty in environmental performance measurement. In a nutshell, pollution output may be stochastic in nature and not entirely the result of direct or preventive management strategies. Many factors outside the workers' control are likely to influence environmental performance, such as the environment's buffering capacity, weather, cumulative effects, or acts of God. It appears in addition that a key role in ensuring a higher control by workers' on environmental performance is played by the technology employed in production process and pollution control (cf. Jones and Klassen, 2001). In sum, the first four limitations about the design of EPMs might result in performance measures that are overall unclear and cumbersome to define. The fifth limitation, which rises in presence of stochastic processes, contributes to an additional level of managerial uncertainty. Goldsmith and Basak (2001) conclude that the output produced by the agent and measured by EPMs scores is uncertain, possibly providing an imprecise and unclear measure of true environmental stewardship. The implications for these drawbacks are several. On the agent's side, they argue that the lack of precision and clarity associated with the EPMs might create incompatibility between his incentives and his corresponding motivation to exert effort. If the agent's incentive scheme is based on an imprecise measure, he may chose not to participate because the risk of being unfairly evaluated may be too high. The lack of precision may also fall short of providing the agent with an incentive to select a high effort level, as opposed to a low effort level. For the principal, if the EPMs are poorly specified, he has no way of measuring his worker's performance. Also, an imprecise measure may cause the principal to offer the wrong incentive to the agent, resulting in sub-optimal levels of effort, which in turn will negatively affect environmental performance and increase the principal's risk exposure.

Finally, Lothe *et al.* (1999) and Lothe and Myrtveit (2003) examine the role of conflicting objectives between environmental and financial performance as restrictive condition for EPMs to be appropriately used in incentive scheme. Their argument is based on the premises that the relationship between environmental performance and financial performance needs to be examined as a multi-period issue that is contingent upon several factors. More specifically, they propose four possible situations that might vary from company to company, or within the same company over time (refer to Table 3.2).

Table 3.2 – Correlation environmental performance - financial performance (source: Lothe *et al.* 1999:315)

	Positive relationship	**Negative relationship**
Short run	Cell 1: Non-conflicting goals (+)	Cell 3: Conflicting goals (-)
Long run	Cell 2: Non-conflicting goals (+)	Cell 4: Conflicting goals (-)

For some types of companies, the use of financial resources to implement environmental management activities might be equated with "traditional" business investments that are expected to generate a financial return both in the short and in the long run. For instance, the introduction of a "green product" in the portfolio of an electronic manufacturer might be supposed to enhance a company's market share and profitability (shift from Cell 1 to Cell 2). For other companies, high initial investments might be required (i.e. for introducing clean production technologies to reduce emissions or energy consumption), though, over time, profits could be expected to increase due to enhanced process efficiency or reduced environmental taxation. In this situation, conflicting goals are expected to emerge in the short run but not in the long run (transition from Cell 3 to Cell 2). For firms where the investments to improve environmental performance never pay back, a persistent goal conflict can be expected both in the short and long run (from Cell 3 to Cell 4). Lastly, it is plausible that companies invest in pollution control and abatement technology to improve environmental performance in the short run, while abatement might become very costly in the long run where more radical technologies are needed to substitute the more obsolete ones. In such a case, a conflict between environmental performance and financial performance might not be present in the short run, but could possibly emerge later on in the long run (move from Cell 1 to Cell 4). In the paper, it is finally suggested that the design of an appropriate compensation system depends upon the availability of EPMs. Regardless of the path that a company is expected to follow with respect to the ones highlighted above, the authors suggest the adoption of a multiplier model where a score of environmental performance is multiplied by a bonus based on financial performance. This solution resembles an incentive system in a multi-task setting coupled to a Balanced Scorecard.

To summarize, a few papers in environmental economics drew upon the multi-task principal-agent model of Holmstrom and Milgrom (1991) to identify the conditions for an appropriate design of contractual incentives in the area of environmental management. The analytical models hinge upon the fundamental assumption that environmental performance measures are necessary for a properly functioning agency relationship based on incentive contracts. At the crux of the issue of designing optimal contracts that align managerial effort towards the accomplishment of environmental objectives remains the problem of defining and measuring environmental performance measures. Measurement aspects that are expected to affect properties of environmental performance measures complicate the design elements of the contract.

Despite their reference to early economics literature on incentives and rewards, the papers that developed from an environmental economics perspective are not connected to more recent developments over performance measurement choice in "mainstream" (managerial) accounting literature. This seems quite unfortunate for the advancement of knowledge in the area, provided that they address similar fundamental issues and formalize analytical arguments that need to be empirically tested. In fact, even though with a slightly different terminology, it appears that the studies in environmental economics discuss and model the same three properties related to the informativeness principle (*sensitivity* and *noise* in Banker and Datar, 1989) and *congruity* (Feltham and Xie, 1994; Datar *et al.*, 2001; Baker, 2002) that are treated in accounting literature (refer to the review in Section 2.3.2). More specifically, the concepts of *sensitivity* and *precision* of performance measures were addressed by Goldmsith and Basak (2001) in their analysis concerning the five limitations of EPMs. Some limitations refer or overlap with the theoretical analog of *sensitivity* of a performance measure, which can be defined in this setting as the extent to which an agent's action has a large expected effect on an environmental performance measure. In economics jargon, environmental performance measures are posited to be more sensitive if their variation is captured by changes in the level of management's actions. Management actions can be viewed here in terms of the effort (that denotes here both its "direction" and its "intensity") the agent expends in selecting and implementing decisions.[7] Second, it is posited that EPMs *precision* refers here to the proportion of the variation in the environmental performance measure explained by an agent's actions. Precision (i.e. the inverse of *noise*) is also defined in the agency literature as the inverse of the variance in the performance measure given the agent's action. In that vein, precision of a performance measure captures the perceived importance of factors outside a manager's control that tend to affect the performance measure. The term "signal-to-noise ratio" combines sensitivity and precision into one concept and compares the sensitivity of a measure to its level of noise. The informativeness of a measure is posited to increase with increased signal-to-noise rations (Banker and Datar, 1989).

A separate issue concerns the potential conflicting objectives between the attainment of environmental performance and the effects on financial performance, theoretically addressed by Lothe *et al.* (1999) and Lothe and Myrveit (2003). These papers make the explicit assumption that environmental management entails decisions of multi-task nature. The lack of conclusive evidence about the "it-pays-to-be-green" hypothesis as reviewed in Section 2.2.7 suggests the presence of complex dynamics between environmental and financial dimensions of performance. There are in this respect multi-period and causality issues that make the formulation of hypotheses about these dynamics problematic. At a conceptual level, this dilemma centers around the key property of performance measure *congruity* that is formulated in economics (Baker, 2002) and accounting literature (Feltham and Xie, 1994; Datar *et al.*, 2001). Congruent measures weight the various objectives that the project manager pursues, according to the objectives of the organization. A consequence of using non-congruent measures is that a manager allocates his effort differently from what the organization would want the manager to do. As such, it is not just a matter of inducing agent to expend effort, as principals want a manager to expend it in an appropriate direction. In the empirical setting of this study, congruity of environmental performance measures is interpreted as the degree of congruence between the impact of an agent's action on environmental performance measures and on the principal's payoff measured in terms of financial performance. In other words, environmental performance measures are more congruent (or less *distortive* in the terminology of Baker, 2002) when an agent's action that improves environmental performance also improves a firm's value. More precisely, what matters is not whether the measure is correlated with firm value, but whether the change on environmental performance measures covaries with the change in financial performance measures (Baker, 2002:736).

The objective in this study is to empirically address the above mentioned three properties of EPMs in the attempt to provide exploratory evidence of the analytical insights conceptually modeled in agency theoretical papers from environmental economics. For the purposes of this study, the three properties examined will apply to environmental performance measures as a whole, without making a distinction between properties that might refer to certain typologies of EPMs. In other words, sensitivity, precision and congruity of EPMs will be investigated by referring to these performance measures as a unified typology of performance measures.

Use of environmental performance measures

With regards to the dependent variables proposed in the model, I explore *extent* and *manner* of use of EPMs. In this way, I attempt to contribute to extant debate in management accounting concerning the issue of "different uses for different purpose" that was highlighted in recent literature reviews. Among them, Ittner and Larcker (2001:382) in particular point out that prior studies on performance measurement choice tended to examine only one or few uses of performance measures (e.g. compensation and problem identification) while ignoring other potential uses. As discussed in Section 2.3.1, some studies refer to the decision-*control* (*decision-influencing*) role of management accounting information (e.g. Abernethy and Lillis, 1995; Chenhall, 1997; Perera *et al.*, 1997), while other studies refer instead to the decision-*making* (*decision-facilitating*) role of management accounting information (e.g. Chenhall and Morris, 1986; Bouwens and Abernethy, 2000; Davila, 2000). Regarding the use of management accounting information for the two purposes, Zimmerman (2003:684-685) notes that:

> *"A critical task is linking the decision rights with the knowledge to make the decision. …One would expect the information used for ratifying and monitoring (control) to be qualitatively different from the information used in initiation and implementation (management)".*

In some instances, thus, there are trade-offs between uses of performance measures and managerial accounting procedures that might foster better decision-making but sacrifice some control (or vice-versa). The textbook examples of a trade-off between decision-making and decision-control refer, for instance, to the use of absorption costing (which facilitates cost management decisions at the cost of potential incentives fro managers to produce inventory) and activity-based costing (which provides more accurate cost data to the detriment of controlling the cost drivers used) (Zimmerman, 2003). In other instances, the two roles for managerial accounting information complement each other, in the sense that the use of information for one purpose (e.g. contracting) enhances the use of information for another objective (e.g. decision-making). Prior experimental studies provide insights about the complementary nature of managerial accounting practices. For instance, evidence from Drake, Haka and Ravenscroft (1999) and Sprinkle (2000) lends support to the interdependent effect of incentive systems on decision-facilitating purposes. On the other hand, as noted by Shackell-Dowell (2002), no empirical or field study in management accounting addressed the link between a manager's motivation and reward system and his use of decision-making information. Extending the issue to other academic disciplines, prior research concerning decision-making in the information management literature has confirmed the complementary link between the two uses. It appears that firms modify the information for decision-influencing purposes to influence an agent's actions, and the agent responds to the system by choosing decision-relevant information (Gorry and Morton, 1971) according to the characteristics of the decision-maker (Mason and Mitroff, 1973). These frameworks are relevant for information management research, but they do not enable to develop predictions for managerial accounting research. More problematic, this literature provides little insight from which to motivate expectations concerning the use of environmental performance measures for decision-making and decision-control. In this study, I explicitly assume that the use of EPMs for decision-making and the use of EPMs for decision-control do not represent two orthogonal constructs. I expect that complementary relationships exists between the two uses. As a consequence, the two uses are simultaneously investigated. In line with this reasoning, I define the variable *use of EPMs for internal control* as the extent to which environmental performance measures are used within an organization for both decision-making and decision-control purposes. The construct is intended to capture varying degree of relevance associated to the use of EPMs for planning and control activities within organizations. It should be interpreted as an initial attempt to discriminate management control systems that extensively rely upon environmental metrics from situations in which the role played by these indicators appears to be negligible. For this study, the use of performance measures focuses on *absolute* use, rather than a relative use of EPMs compared to other sets of performance indicators.

Contrary to the internal use of environmental performance measure, it is posited here that the use of the same performance measures is conceptually different from the purpose of providing external information to companies' shareholders and stakeholders. In the same vein, Ansari and Euske (1987) proposed two dimensions along which the role of accounting information in organizations can be analyzed (refer to Table 3.3). First, a dichotomy exist between information that is recorded and used for internal purposes (cell 1), in contrast with information that is used to mediate the relationship between an organization and its technical environment (cell 2). Second, a difference is posited between a technical-rational use of accounting information (cell 3), versus the use of information in a legitimizing way as ammunition to justify organizational actions (cell 4).

Table 3.3 – Roles of accounting in organizations from Ansari and Euske (1987:553)

	User group location	
Focus of organizational process	***Internal***	***External***
Technical-rational	1. Measuring technical efficiency	2. Resource allocations
Natural	3. Behavior changes; politics	4. Gaining legitimacy

Such a classification can be applied to the empirical setting of environmental management to distinguish two main uses of environmental performance measures. In this study I make a distinction between use of environmental performance measures for internal control and use of environmental performance measures for *external accountability*. Gray, Owen and Adams (1996) propose a broad definition of accountability as follows:

> *"Accountability can be defined as the duty to provide an account (by no means necessarily a financial account) or reckoning of those actions for which one is held responsible".*

Accountability denotes different meaning in the accounting literature (cf. Ijiri, 1983; Kluvers, 2002). The research interest around the accountability concept stems predominantly from interpretative tradition of management accounting research at the organizational level of analysis. The objective of this literature is to examine how organizations make use of (accounting) information as legitimating device in the eyes of stakeholders and shareholders (Roberts and Scapens, 1985). Most empirical studies focus on the accountability mechanisms in the public sector (cf. Sinclair, 1995; Parker and Gould, 1999). In contrast, a separate stream of studies developed at the individual level of analysis referring to the notion of accountability introduced by the seminal studies by

Tetlock (cf. Tetlock, 1992; Lerner and Tetlock, 1999). This latter tradition follows the psychological implications of accountability, particularly in the research area of auditing. On the contrary, this study refers to and builds upon the latter domain of accountability being the research focus at the organizational level of analysis. I define the use of environmental performance measures for external accountability the extent to which organizations rely on these measures to gain legitimacy towards shareholders and stakeholders.

Environmental or, more recently labelled, sustainable reporting represents the practical area in which the use of environmental metrics for external accountability is mostly diffused. This development is clearly illustrated by recent surveys of practice which indicate an increased integration of environmental-related information in traditional financial reports, alternatively labelled as sustainable or Triple Bottom Line reports (e.g. KPMG/UvA, 2002; PriceWaterhouseCoopers, 2002; Kolk, 2004). I have discussed in Section 2.2.5 that, mainly drawing upon institutional theory (Meyer and Rowan, 1977; DiMaggio and Powell, 1983; Scott, 2001) or legitimacy theory, researchers from the *"Stakeholder accountability"* approach in environmental accounting literature argue that companies use their environmental-related measurement systems as a predominantly public relation device without relying upon it for running the business (e.g. Gray *et al.*, 1995; Larrinaga-Gonzalez and Bebbington, 2001; Larrinaga, Carrasco, Correa, Llena and Moneva, 2002). The term "greenwash" emerged to reflect an increasing apprehension that corporations creatively manage their reputations with the public, financial community, and regulators, so as to hide deviance, deflect attributions of fault, obscure the nature of the problem or allegation, reattribute blame, and finally reassure their reputation (cf. Laufer, 2003). The defensive strategies employed by firms to protect against entity liability are aimed both inside and outside the organization along three elements of deception ("*confusion*", "*fronting*", and "*posturing*") as explained by Beder (1998; 2002):

> *"Internally, 'confusion' flows naturally from the complex nature of the corporate form, reliance on decentralized decision making, and the practices of managerial winking. 'Fronting' is accomplished through the representations of retained counsel, compliance officers, ethics officers, and ethics committees. 'Posturing' seeks to convince internal customers, as much as external stakeholders, of the organization's collective commitment to ethics. … Externally, the firm achieves 'confusion' by careful document control and strict limits on the flow of information made available to regulators and prosecutors. 'Fronting' is realized by subordinate scapegoating or reverse whistle blowing. 'Posturing' is accomplished through active use of the corporation's public affairs department and, if necessary, the retention of an outside public relations firm"*.

The separation in this study between internal control and external accountability purposes is expected to contribute to a further theoretical and empirical understanding of the reasons behind the diffusion and the actual use of environmental performance measurement. I believe in this way also the shed some light on the "greenwashing" issue that appeared to capitalize the interest of accounting research from SEA critical school.

In sum, I distinguish first an *internal* use of EPMs which comprises a simultaneous use of environmental-related information for managerial control purposes (decision-making and decision-control). Second, I address the *external* use of EPMs which focuses on the provision of information about corporate environmental performance to external constituencies (shareholders, stakeholders, government officials, local communities and the public at large) for accountability purposes.

3.2.2 Hypothesis development

As far as the assumptions behind the model, I refer to the literature in management accounting that examined strategy-MCS relationship using structural contingency theory (see Fisher, 1995; Langfield-Smith, 1997; Fisher, 1998; Chenhall, 2003; Gerdin and Greve, 2004). The basic theme in contingency research is that management control systems must somehow match organizational context and structural characteristics in order for an organization to perform well. As reviewed by Gerdin and Greve (2004), different forms of fit have been applied in the management accounting literature without an explicit recognition by researchers of the implications of their choice on theory building and testing. Drawing upon analysis of contingency theory from management literature (Drazin and Van de Ven, 1985; Venkatraman, 1989), a major distinction within the Cartesian[8] notion of fit refers to the concepts of *congruence* and *contingency* fit. The operational concept of fit as congruence holds that fit is a combination of the levels of the contingency and structure that produce higher performance (Fry and Smith, 1987). Pfeffer (1982) refers to this aspect of structural contingency theory as the "consonance hypothesis", meaning "*that those organizations that have structures that more closely match the requirements of the context will be more effective than those that do not*". Fit as congruence reflects a criterion-free specification and implies an assessment of relationships between variable pairs with no explicit evaluation of impact on a criterion variable (i.e. performance). Within a congruence model, a *selection*-fit approach considers fit as a result of an evolutionary process of adaptation that ensures that only the best-performing organizations survive (Drazin and Van de Ven, 1985). Similarly to economics, a contingency-based approach presupposes that equilibrium between environment and organization exists, at least over long period of time because an isomorphic relationship between context and structure is posited for the surviving organizations (cf. Luft and Shields, 2003). Unlike economics, however, contingency theory assumes that misfit also occurs in some organizations for periods of time. Donaldson (2001) proposed that structural adaptation occurs to regain fit. This holds that there is fit between each contingency and one (or more) aspect of organizational structure, such that fit positively affects performance and misfit negatively affects performance. An organization initially in fit changes its contingency, thereby moving into misfit and suffering from declining performance. This causes the adoption of a new structure so that fit is regained and performance restored. Hence, the cycle of adaptation consists of: fit, contingency change, misfit, structural adaptation, new fit (Donaldson, 1996). Under this assumption, it is possible to provide non-experimental evidence about determinants of structural adaptation.

In this study, it is plausible to assume that at present times companies are not in equilibrium with respect to their environmental performance measurement systems. Anecdotal evidence and professional literature provide initial insights about a limited amount of organizations ("best-in-class" companies) that have developed sophisticated environmental management information systems. The extent to which these companies use them to support their traditional management control systems has been subject of limited empirical investigation. Meanwhile, many other companies appear to experiment the introduction of environmental management accounting with varying degree of sophistication. As a consequence, it can be expected that a sufficiently large number of organizations have not achieved fit yet. If the argument is taken that environmental management accounting presents alternative forms of performance management that require some time before they diffuse, it follows that we are in presence of a lag in its adoption similar to any management accounting innovation (cf. Foster and Ward, 1994; Luft, 1997). When such a mismatch condition can be envisaged, some organizations may move from misfit to fit more slowly than others depending on several factors. As I have discussed in Section 2.2.5, in this specific context, institutional, organizational and individual factors simultaneously affect the adoption of environmental management and accounting. It is not the aim of this study to examine the length of the causal intervals within an economic system to determine whether it is in equilibrium (the case study presented in Chapter 6 will allow the discussion of dynamic aspects of performance measurement in the area of environmental management). More simply, the nomological network proposed in this study preliminary explores the strategy-MCS link by focusing on the nature of context-structure relationships without modelling their effect on performance. This model choice is coherent with the remark by Chenhall (2003:135) about the need of further empirical research in management accounting that recognizes different stages of theory building:

> "*If disequilibrium conditions are assumed, then it may be useful for contingency-based studies to first establish adoption and use of MCS, then to examine how they are used to enhance decision quality and finally investigate links with organizational performance*".

To summarize, I expect that most organizations that are supposed to use environmental performance measures in fact do so. However, given the high experimentation in practice at present times in this area, traditional performance measurement systems may not be optimally matched to provide reliable and relevant environmental–related information for planning and control. While some companies already adapted their MCS to fit the needs of environmental management, other companies may lag behind. Despite the absence of equilibrium, it can be argued that the move from misfit to fit conditions can be empirically observable. As Milgrom and Roberts (1992) suggest, all organizations may be dynamically learning and moving toward the optimal level, but a cross-sectional sample will consist of observations that are distributed around the optimal choice. The framework in this section applies therefore a *selection*-fit model within the *congruence* approach of traditional structural contingency theory (cf. Gerdin and Greve, 2004). Further, the observed cross-sectional variation in environmental accounting practices in the empirical part of this study allows the exploratory assessment of the fit in terms of performance consequences of managerial accounting choices. Accordingly, the effects associated with the use of environmental performance measures will be discussed and investigated in the second part of the chapter (Section 3.3). The directional hypotheses for each of the relationships proposed in the conceptual model about determinants of environmental performance measures are developed next.

Environmental strategy and the use of environmental performance measures

The approach followed in management accounting textbooks prescribes adaptation of MCS design and use in alignment with organizational strategic objectives (Simons, 2000; Brickley *et al.*, 2001; Merchant and Van der Stede, 2003; Zimmerman, 2003). In particular, according to Simons (2000:16):

> *"Business strategy is at the root of effective performance measurement and control for two reasons. First, performance measurement and control systems provide the analytic discipline and communication channels to formalize business strategy and ensure that strategic goals are communicated through the business. Second, performance measurement and control systems are the primary vehicle to monitor the implementation of these strategies".*

In the same vein, Langfield-Smith (1997:207) stated that *"the MCS should be tailored explicitly to support the strategy of the business"*. Similarly, Ittner and Larcker (1997:297), affirmed that *"a key assumption in the strategic control literature is the need to align specific control practices with the organization's chosen strategy"*. As reviewed in Section 2.3.1, previous research supports the evidence of an association between business and operational strategies and performance measurement choice. In particular, different studies provide evidence that the implementation of advanced manufacturing technologies like Total Quality Management (TQM) and Just-In-Time is accompanied by a more extensive use of non-financial measures for both planning and control. As it was discussed in Section 2.2.1, formal environmental management systems share many similarities to TQM managerial principles. I explained for instance that voluntary certification schemes built upon analogous managerial principles are available for quality management (i.e. ISO 9000 series) and environmental, health and safety management (i.e. ISO 14000 series). Recent surveys of practice indicate that these managerial systems are often integrated as companies tend to be certified for quality, environmental and safety practices by relying upon common third-party certification procedures (Corbett and Kirsch, 2001). The empirical evidence about the extent of this integration in traditional management control systems is available predominantly from professional literature, particularly to illustrate some applications of the Balanced Scorecard (see, for instance, the example of Mobil Co. in Kaplan and Norton, 2000). As far as academic research is concerned, only few papers address the issue from a management control perspective (Nilsson *et al.*, 2000; Wisner *et al.*, 2002).

By extending the findings from existing literature on quality management to the environmental management setting, I posit that a company's strategy focused on environmental aspects exerts an effect on the use of environmental performance measures. In particular, the extent to which companies might rely upon these non-financial metrics is a function of the strategic position with respect to environmental-related issues. As organizations adapt to incorporate environmental-related aspects in their business strategy, they must make sure that the use of environmental performance measures is aligned with the new control requirements. Environmental-related objectives put great demands on the organization for coordination and close control of environmental risks and environmental impacts. Environmental performance measures are crucial to ensure that the implementation of an environmental strategy is effectively executed. I expect therefore that companies more advanced in the implementation of their environmental strategies (more *proactive* companies) *use* environmental performance measures to a greater extent than companies that lag behind with respect to their environmental-related practices (more *reactive* companies).

In sum, I adopt a line of reasoning similar to prior management accounting studies in which it is argued that the use of specific performance measures is positively associated to the implementation of operational strategies like TQM and JIT. I therefore explore the relationship between environmental management and use of environmental performance measures by formulating the following hypothesis:

H1: *Environmental strategy positively influences the use of environmental performance measures, such that a more environmentally proactive strategy is associated with a higher use of EPMs for a) internal control and b) external accountability.*

I expect no difference in the direction of the relationship between decision-making and control purposes. On the one hand, the increased availability and use of environmental-related data associated to proactive environmental strategies is likely to reduce uncertainties[9] and environmental risks. On the other hand, according to both economic and organizational literature, organizational change is expected to accompany the implementation of environmental management: the emphasis on environmental objectives should be reflected in changes of management control systems in order to align decisions and motivate employees' effort towards the attainment of environmental strategy (cf. Wruck and Jensen, 1994). My expectation is that companies that are more advanced in terms of environmental strategy rely more extensively on environmental information in their performance evaluation and reward systems. I am interested in particular to document the *formal* use of these metrics, as the empirical evidence available in the area is particularly limited also from the literature in environmental management (cf. Chinander, 2001).

Sophistication of environmental management information system and use of environmental performance measures

An organization's ability to survive and function successfully in an environment of intense competition depends partially on the availability and quality of accounting information upon which its managers can take decisions and evaluate performance (Ittner and Larcker, 1998b; Hartmann, 2000). Chenhall and Langfield-Smith (1998b) emphasized that:

> *"Strategic priorities should be supported by appropriately and effectively implemented manufacturing processes and information systems, including those providing management accounting information"*.

Previous studies have indicated that organizations using more efficient production practices adapt their performance measurement systems, in particularly relying more on non-financial information (e.g. Daniel and Reitsperger, 1991; Abernethy and Lillis, 1995; Ittner and Larcker, 1995; Ittner and Larcker, 1997; Sim and Killough, 1998). The integration of non-financial performance measures in measurement systems allow managers to better understand the relations among various strategic objectives, to communicate the association between employees' action and strategic goals, and to allocate and set priorities based on those objectives (Ittner and Larcker, 1998b; Said *et al.*, 2003). Both decision-making and control purposes provide the foundation for an alignment between the strategic priorities of an organization and its performance measurement systems. From a decision-making perspective, it is argued that managers need appropriate data to take actions consistent with a given strategy. Performance measurement systems enable to better understand input/output relationships, facilitating the coordination of activities among organizational subunits (Galbraith, 1973). From a decision-control perspective, managers have an incentive to improve those areas in which their performance is measured and evaluated (Perera *et al.*, 1997).

Drawing on an analogy with quality management principles and practices, environmental management is an information-intensive system that requires a high level of information flow 1) within the organization and 2) between the organization and its external stakeholders (Moore, 2002). Firms aiming to integrate environmental issues more systematically in their planning and control systems face the challenge of generating appropriate data, both of financial and non-financial type (Schaltegger and Burritt, 2000). Environmental management practices emphasize commitment to reduce the environmental impact of company's operations and continuous improvement through the use of environmental data-decisions. As pointed out by Epstein (1996:75-76):

> *"The success of an environmental strategy implementation depends on accumulating, aggregating, measuring, and reporting information related to corporate environmental impacts to various managers within the corporation. Thus the development and improvement of these systems is critical".*

So far, a limited attention has been given to measurement-related issues regarding the design of environmental information systems (Rikhardsson, 2001). Professional literature increasingly reports about companies that invest in their environmental information systems (e.g. Lambert, Jansen and Splinter, 2000; Holliday *et al.*, 2002; Rikhardsson and Vedsø, 2002). Commercially available environmental management software packages have evolved to the point where most include modules for hazardous materials inventory, emissions reporting, and compliance activity documentation. Richards, Allenby and Compton (2001) provide an overview of the integration of information systems, organizations and environmental initiatives. For instance, Koehler (2001) describes the change in the internal accounting system occurred in Baxter International to accommodate the managerial need of a more sophisticated environmental information. Shaft, Sharfman and Swah (2002) examine how information systems can help an organization to move towards environmentally responsive business practices. They identify a range of organizational information systems and discuss how these systems may support environmentally oriented decision-making. Limited anecdotal evidence is available about the extent of the integration of environmental performance measures in performance management (Epstein, 1996; Reinhardt, 2000; Holliday *et al.*, 2002). Scant evidence though exists in academic literature about the relationship between environmental strategy and dimensions of management accounting information. As far as I know, the only study available about this link is Pondeville (2003), which examined the link between environmental strategy and the attribute of *broad scope* environmental information system, providing evidence of a positive and significant effect of strategic choice on MCS design.

In this study, I posit that the sophistication of the information provided by the environmental management information system (EMIS) is a necessary condition to ensure managers to take actions and receive feedbacks consistent with a given environmental strategy. I explore whether firms emphasizing the reduction of the environmental burden of their operations tend to develop EMIS that are more sophisticated in comparison with firms in which this strategic dimension is not emphasized. To encourage individuals to make lasting changes in behavior, management must redefine the organization's objective and communicate the environmental-related objectives to employees (Lanen, 1999; Chinander, 2001). Like in TQM programs, performance measurement systems facilitate the communication process because they establish measures that define levels of environmental performance and set goals for improvement (Daniel and Reitsperger, 1991; Wruck and Jensen, 1994).

Overall, I expect that the level of sophistication of an EMIS will depend upon the strategic choice of the company with regards to its environmental management. Based on previous considerations, the following exploratory hypothesis is formulated:

H2: *Environmental strategy positively influences EMIS sophistication, such that a) availability, b) scope, c) timeliness and d) accuracy of environmental performance measures increase as the implementation of a proactive environmental strategy increases.*

The third hypothesis illustrated in the model focuses on the links between dimension of EMIS sophistication and use of EPMs for internal control and external accountability. I develop arguments drawing analogies from prior streams of management accounting literature. First of all, the reliance upon performance measures should necessarily depend on the availability of the same measures. Accounting researchers have drawn upon information technology implementation literature to argue that the use of, so-called, innovations like Activity-Based Costing should be a function of the current information system's characteristics (e.g. Shields, 1995; Krumwiede, 1998; Anderson and Young, 1999). Design or implementation problems of performance measures might represent a major impediment for the development of an information system to provide required data (Gates, 1999). Thus, performance measures need to be available as a precondition for their use. As a related argument, if limitations of information systems prevent managers from receiving data with expected characteristics, the performance measurement system's use for both internal and external accountability is likely to be limited. Evidence for this argument is provided by recent studies that examine how different characteristics of performance measures affect their use for decision-making or control. For instance, Cavalluzzo and Ittner (2004) found that the use of performance measures in governmental agencies is a function of the development (i.e. availability) of performance measurement system. In a hospital setting, Abernathy and Vagnoni (2004) hypothesized and empirically found that the use of accounting information is dependent upon physicians perceptions of the design criteria associated with the MCS. They also expected that the design characteristics of the system influenced the importance placed on MCS in controlling behaviors of physician managers by top management. Their hypothesis was based on Milgrom and Roberts' expectation (1992) that, if the information relating to managerial actions is too late, inaccurate, or does not capture the desired set of behaviors, superiors are unlikely to rely on this information for measuring subordinate performance. In another study, Gibbs *et al.* (2004a) examined the role of accurate (i.e. reliable and objective) performance measures in investigating the determinants of subjective performance evaluation, positing and empirically testing that accuracy is a significant determinant of performance measure use. Further, Libby, Salterio and Webb (2004) found that experimental subjects in management control tasks rely more on performance measures that have been verified by third-parties, which might create demand for accurate and objective measures.

In the area of environmental management accounting, no prior study has explicitly investigated the relationships between perceived sophistication of environmental performance measure and related use. There is anecdotal evidence suggesting that most companies are in their initial stage of EMIS development (Bennett and James, 1998a; Bartolomeo *et al.*, 2000; Parker, 2000b). I rely therefore on the expectations from management accounting studies, proposing that the use of environmental information is dependent on the sophistication of an environmental information system. In other words, the quality of the information is expected to influence the use of the performance measures. This leads to the third hypothesis stated separately for the two uses (internal control versus external accountability):

H3: *The sophistication of EMIS positively influences the use of environmental performance measures for* ***internal control****, such that the use of environmental performance measures increases with a) increased availability, b) broader scope, c) more timely, and d) more accurate EMIS;*

and:

The sophistication of EMIS positively influences the use of environmental performance measures for ***external accountability****, such that the use of environmental performance measures increases with e) increased availability, f) broader scope, g) more timely, and h) more accurate EMIS.*

It is important to emphasize that Hypotheses H1 and H3 refer to both internal and external accountability purposes. The business literature about performance management increasingly argues that value driver analysis should influence design and use of measurement systems, but should also affect external disclosure requirements. This use of performance measurement is consistent with calls in the financial accounting community for greater disclosure on information on key value drivers (Ittner *et al.*, 2003b). Given the exploratory nature of the study, I assume no differential impact in terms of sign of the antecedents examined on EPMs use. The empirical results will provide an indication of the magnitude of the effects.

Properties of environmental performance measures

Concerning the intervening role of EPMs properties in the relationship between environmental strategy and use of EPMs, two types of issues complicate the development of plausible hypotheses. First, assumptions and concepts that are developed and used in agency theoretic papers need to be translated into analog assumptions and concepts that can be applied to the context under investigation. Lambert (2001) notes that the possibility to apply agency theory to specific individual parameters can be considered as both “blessing and curse”. The blessing refers to the conceptual flexibility to explain various forms of contractual arrangements, while the curse is related to the difficulty of empirically measuring many of the properties modelled in abstract. Prior attempts from environmental economics to bridge economics-based insights of principal-agent models to the specific area of environmental performance measurement provide a point of departure that will be followed in this study (see Section 3.2.1). Nevertheless, these preliminary findings provide little guidance on the implications that agency theoretic models have in practice. Second, a problem arises in association with the translation of the conceptual aspects modeled in analytical terms into measurable instrumental variables. I will address this issue in Chapter 4, while here the attention is devoted to the formulation of (1) hypothesis H4 about the link between environmental strategy and EPMs properties; and (2) hypothesis H5 concerning the relationship between EPMs properties and their use for internal control.

Referring to the informativeness principle as determinant of performance measurement choice, a number of cross-sectional studies in management accounting examined the *relative* weights placed on specific individual, non-financial or subjective performance measures in compensation and incentive systems (e.g. Bushman *et al.*, 1995; Ittner and Larcker, 1997; Ittner *et al.*, 1997; Ittner and Larcker, 2002a; Ittner *et al.*, 2003a; Gibbs *et al.*, 2004b). Two approaches are generally followed to confirm hypotheses about the implications of the principle. First, noise of performance measures is examined focusing on the variance in objective, financial performance measures for compensation and reward purposes. In these studies, it is assumed and tested that the weight placed on financial measures in incentive contracts is negatively correlated with their noise, while the weight of other performance measures is expected to increase. The empirical evidence shows that noise of financial performance measures tends to be positively associated with weights on non-financial performance measures (e.g. Ittner *et al.*, 1997) and negatively correlated with weight on financial performance (e.g. Lambert and Larcker, 1987). Most of the empirical literature has focused so far on CEO compensation schemes given the limited availability of data at lower levels of analysis (see Ittner and Larcker, 2002 for a study at the lower, operational level). The second diffused approach in this literature is to employ a few proxies from archival data that are expected to affect the informativeness of specific performance measures. It appears that one of the most frequently proxy of a measure’s informativeness is the contingency variable organizational *strategy* (Ittner and Larcker, 2001; Luft and Shields, 2003). The underlying argument is that the emphasis on strategy implementation determines the extent to which a set of performance measures is informative and positively affects the achievement of a company’s strategic objectives (Ittner and Larcker, 2002a). So, for instance, it is assumed that the primary goal for firms following a cost leader strategy is increasing efficiency relative to the prior period. Consequently, short-term financial measures such as accounting returns and cost control are expected to be relative informative indicators of managers’ performance (e.g. Govindarajan and Gupta, 1985). Likewise, Ittner *et al.* (1997) found that the weight placed on non-financial measures for CEO compensation are positively related to an organization’s use of innovation-oriented strategy and adoption of quality programs (proxies for congruity and precision). In brief, it is generally found that the use of strategy variables as proxies for factors predicted to influence informativeness (sensitivity and precision) of performance measures are associated with increased weights on these measures. As noted by Ittner *et al.* (2003a:729), however, the use of indirect proxies to measure informativeness properties of performance measures represents a significant limitation of extant empirical studies. To my knowledge, only Moers (2001; 2004) explicitly addressed the antecedents of performance measures properties by formally modelling the relationships between variables inherent respectively to uncertainty and organizational structure with informativeness dimensions (sensitivity and precision) of the performance measures used in performance evaluation.

In this study, I rely upon the theoretical arguments of prior literature that considered *strategy* as main predictor of informative characteristics of performance measures. Accordingly, it is posited that an emphasis on environmental strategy is likely to affect the properties of environmental performance measures. In relation to the informativeness properties of sensitivity and noise, I expect that managers employed in companies with more proactive environmental strategies are better able to influence the results of their actions in terms of environmental performance. In presence of advanced environmental management practices, it seems reasonable that managers' ability to affect environmental performance levels increases. In these situations, both technological and managerial devices are supposed to be in place and minimize the environmental-related impacts of business operations. To the extent that this is a valid prediction, EPMs should provide incremental information regarding a manager's actions that is not available from other performance measures. While this reasoning is admittedly not the outcome of formal agency theory, it seems reasonable to expect that in presence of more proactive environmental strategy, environmental performance tends to be perceived as more informative (more sensitive and less noisy) than in situations characterized by more reactive approaches towards environmental management.

Concerning predictions about EPMs congruency, theory development is complicated in this setting by the following considerations. According to the practitioners' literature about environmental management, successful implementation of an environmental strategy requires greater reliance on EPMs in order to foster management commitment to environmental programs, to communicate the significance of these programs to all employees and to ensure that improvements in environmental performance are elevated to the same level of importance as financial performance (Epstein and Birchard, 1999; Reinhardt, 2000; Epstein and Wisner, 2001; Kaplan and Norton, 2003). The literature in environmental economics (Gabel and Sinclair-Desgagné, 1993; Sinclair-Desgagné, 1999; Goldsmith and Basak, 2001; Lothe and Myrtveit, 2003) complements mainstream agency theory models and is aligned with these arguments. The use of EPMs in the design of incentive compensation systems is expected to align the managers' actions, provided that firms put an emphasis on the contractual design of their compensation and rewards schemes (Lothe *et al.*, 1999). As reviewed in the previous section, it is thus expected that the lack of explicit incentives for implementing the environmental strategy, combined with positive incentives linked to financial performance, results in no effort directly spent to improve financial performance. The formulation of hypotheses, however, is complicated by the lack of (or mixed) prior empirical evidence about this argument. Particularly with regard to *congruity* of EPMs, analytical agency models adapted to environmental management assume that the benefits from current environmental programs may not be fully reflected in short-term financial measures (Lothe *et al.*, 1999). Under this empirical condition, these models would suggest a *higher* weight of EPMs in compensation and incentive systems to align the effort of managers towards the achievement of improved environmental performance in the long period. No prior study however has attempted to test the relationships that were analytically modeled for incentives in multiple task setting including environmental performance measures. The only evidence, available from a stream of research focusing on the link between environmental and financial performance, provides mixed results of a positive and significant association (see Griffin and Mahon, 1997; Margolis and Walsh, 2001 as recent reviews). Apart from serious limitations concerning the lack of sound theoretical explanations and valid performance measures (Ullmann, 1985; Ilinitch *et al.*, 1998; Rowley and Berman, 2000), these studies collectively do not confirm that EPMs possess high degree of predictive validity of future (financial) performance (refer back to the evaluation of the CSP-CFP link discussed in Section 2.2.7 and Section 2.2.8).

By referring to extant research in management accounting, Ittner *et al.* (2003) assume that measures that are more predictive of future performance provide greater information on the congruence between the agent's action and the outcomes desired by the principal. There are conceptual and empirical arguments that complicate predictions in this context. The first issue concerns the link between congruity and risk that has been modeled in agency models (cf. Datar *et al.*, 2001; Prendergast, 2002). On this matter, Ittner *et al.* (2003:729-730) argued that:

> *"In an agency setting, the coefficients (or weights) associated with the non-financial performance measures in the structural model linking non-financial performance measures to future financial results (i.e. the 'business model') and the coefficients (or weights) used in the agent's compensation contract will be identical if the agent is risk neutral. However, theoretical models by Gjesdal (1981) and Datar et al. (2001) also indicate that when the agent is risk averse, the coefficients in the business model will not be identical to the coefficients in the compensation model".*

It is reasonable to believe that companies that emphasize more environmental protection in their business strategy should be associated with congruent performance measures for reward and compensation. The demand for improvement in environmental performance formalized in an environmental strategy provides normative support to the idea that EPMs should be used more extensively for planning and control purposes.

In conclusion, in this study I explore the following hypotheses:

H4: *As a company's environmental strategy becomes more proactive, the perceived a) sensitivity, b) precision, and c) congruence of EPMs increase.*

H5: *The use of environmental performance measures for internal control increases with a) sensitivity, b) precision, and c) congruence of EPMs.*

Hypothesis 5 is developed in line with the expectations from economics-based agency models. If informativeness is a determinant of EPMs choice, then I expect greater reliance on the same measures for internal planning and control systems. Given the exploratory nature of this study, the objective here is to detect the *direction* of the relationship between environmental strategy and EPMs properties. Thus, I opt not to test for intensity effects, namely measuring the weight placed on specific performance measures in compensation contracts. In contrast with Hypotheses 2 and 3, Hypotheses 4 and 5 will refer exclusively to EPMs use for internal control since no theoretical argument can be advanced to develop hypotheses that link EPMs properties with their use for external accountability.

Consistency of use of environmental performance measures

In discussing the limitations of empirical management accounting studies that examined performance measurement choice, Ittner and Larcker (2001:385) noted that prior studies:

> *"…do not investigate the consistency in performance measures used for different purposes"*.

On this matter, they presented the results of a survey among 148 financial service firms where they collected data about the perceived importance of a series of performance measures and compare it with their actual use for internal decision-making. In presence of a difference between the two ratings, a so-called "measurement gap" arises. On the contrary, a firm is assumed to have a zero "gap" if the score for internal usage or goal setting is greater than or equal to the perceived importance score. The results exhibit substantial misalignment or "gaps" for all of the higher ranked performance categories, with the exception of financial and operational performance. The inconsistencies vary across uses, indicating that extensive use of performance measures for one purpose does not necessarily imply that the same measures are used for other purposes. The largest gaps relate to the use of customer, employee, and community measures for evaluating capital investments. In a separate study, another analysis referring to the same source of data reflects an inconsistent use of environmental performance measures (Ittner *et al.*, 2003b). While environmental performance measures are perceived as important for long-term success with a mean response of 2.08 (on a Likert scale from 1 to 5), their actual use is reported at lower levels for different purposes (on average, 1.59 for problem identification, 1.70 for capital investment decisions, 1.49 for performance evaluation and 1.57 for external disclosure; cf. Table 1 in Ittner *et al.* 2003b). The researchers conclude that the “measurement gap” displayed from the empirical data needs further understanding regarding the explanatory factors behind an inconsistent use of performance measures.

In the literature about environmental management and environmental accounting, the issue of consistency of use of environmental performance measures focuses on the contraposition between external and internal use of environmental-related information (cf. with the literature review in Section 2.2.2). A growing amount of business publications argue for a consistent alignment between the extent to which companies externally disclose their environmental-related information and their actual managerial control practices (e.g. Epstein and Birchard, 1999; Eccles *et al.*, 2001; Kaplan and Norton, 2003). In particular, Berthelot *et al.* (2003) in their literature review about environmental disclosure indicate that more emphasis in environmental accounting research should address this topic to better examine whether and why companies inconsistently use their environmental performance measures. In the context of the present study, the variable *consistency of use* refers thus to the difference between external and internal use of EPMs. A smaller difference between the two uses implies a higher consistency. On the contrary, a larger difference between the two uses signals inconsistent use. Particularly important is to empirically assess whether the use of EPMs for external accountability prevails on the use for internal control. The latter case would be suggestive of a predominantly legitimizing use of these performance measures that is decoupled from internal managerial control mechanisms (the so-called "greenwashing" effect claimed in Beder, 2002 and discussed in Section 3.2.1).

In this study, I hypothesize a difference in the consistency of use of environmental performance measures that can be explained by the intensity of environmental strategy adopted by an organization. In particular, it can be expected that in early stages of implementation of an environmental strategy, the main use of environmental performance measures would be dictated by compliance to environmental regulation and disclosure of environmental information to stakeholders and shareholders. Instead, companies in later – and more advanced – stages of environmental strategy implementation would rely simultaneously on environmental metrics for both purposes. I posit thus that over time the “measurement gap” between internal and external use tends to be *lower* in companies that have reached a more complete level of environmental strategy implementation. In other words, companies associated with a more proactive environmental strategy should be expected to use their environmental performance measures more consistently than companies that lag behind in this area. Controlling for the intensity of their environmental strategy, the internal use of these measures should be closely matched to their external use. This leads to the following hypothesis:

H6: *Companies with a more proactive environmental strategy use environmental performance measures for internal control and external accountability more consistently than companies with a reactive environmental strategy.*

The hypothesis is exploratory in the sense that the manner of use is broadly distinguished into the broad dichotomy of internal control *versus* external accountability use, without aiming at specifically addressing consistency of use with respect to more specific examples of performance measures.

3.3 Effects of environmental performance measurement systems

In this section I complement the theoretical framework about the determinants of EPMs use with an analysis of the effects associated with the use of environmental performance measures for internal control. The objective is to empirically examine whether the use of EPMs for decision-making and decision-control has a consequence on environmental performance levels. In contrast with the prior conceptual model in which a *congruency* approach of fit was adopted, a *contingency* type of fit is applied here (Gerdin and Greve, 2004). A contingency fit connotes conditional association of two or more independent variables with a dependent variable, usually measuring performance effects. While congruence-type of fit attempts to understand the relationships among the research variables, contingency propositions aim at predicting systems states where the integrity of the systems (i.e. units, laws, relationships and boundaries) is preserved (Fry and Smith, 1987). In a contingency approach, the presence of fit is understood as *positive* impact on performance due to certain combinations of context and structure. Accordingly, it is assumed that high-performing as well as low performing firms do exist as a result of more or less appropriate matching of context and structure. The research objective of contingency propositions is then to explain these variations in performance in terms of relationships between context and structure characteristics (cf. Drazin and Van de Ven, 1985; Venkatraman, 1989; Fisher, 1995; Donaldson, 1996; Fisher, 1998; Donaldson, 2001; Chenhall, 2003).

Contingency research about Cartesian-type of relationships illustrate the possibility of conceptually modelling relationship between variables basically in two alternative variants (Gerdin and Greve, 2004). With a *moderation* approach, it is assumed that the impact of an independent variable on the dependent variable is contingent on the level of a third variable, the so-called *moderator* (Hartmann and Moers, 1999, 2003; Luft and Shields, 2003). In this case, the underlying theory specifies that the third variable moderates the effect that the independent variable has on the dependent variable (Venkatraman, 1989). A fundamental assumption of moderation forms of fit (alternatively labelled as *interaction* approach in Drazin and van de Ven, 1985)[10] is that the moderator variable has "*nonsignificant, bivariate relationships with both the independent and* *dependent variables"* (Shields and Shields, 1998:51). This implies that a moderator variable needs not to be theoretically related with either the dependent or the independent variable. In case this prerequisite is not fulfilled, the moderation form of fit does not provide an accurate estimate of the "true" relationship between variables (cf. Hartmann and Moers, 2003:807-808 for a discussion of this issue in the area of budgetary studies). In these conditions, alternative model specifications are needed. The other variant commonly used in contingency models refers to the *mediation*-fit approach (Drazin and Van de Ven, 1985; Luft and Shields, 2003; Gerdin and Greve, 2004). The mediation perspective of fit (alternatively labelled as s*election* approach in Drazin and van de Ven, 1985) specifies the existence of a significant intervening mechanism between an antecedent variable and a consequent variable (see Chong and Chong, 1997; Williams and Seaman, 2002; Hoque, 2004 for examples of contingency mediational models in management accounting research). Thus, while moderation-fit specifies varying effects of an independent variable on a dependent variable as a function of the moderating variable, mediation-fit approach implies the existence of intervening (indirect) effects between an antecedent variable and its consequent variable (Venkatraman, 1989). Gerdin and Greve (2004) pointed out that the moderation and mediation types of models provide alternative theoretical explanations if applied to a particular situation. Concerning the validation of models containing management accounting systems (MCS) as a choice variable (congruence form of fit) in alternative to a dependent variable (contingency form of fit), they argued (Gerdin and Greve, 2004:310):

> *"…[s]ince the moderation and the mediation forms of fit have fundamentally different theoretical meanings, results based on one of the models cannot be validated with results obtained from the other. In other words, the MCS cannot concurrently play both the role of a moderator (and thus be independent of strategy) and the role of a mediating variable (and thus be dependent of strategy)".*

The choice for a model specification about performance effects of strategy-MCS relationships in the empirical setting of this study is problematic for two reasons. At first, problems raise in presence of a performance variable that is measured in a static way at one point in time, whereas notions of fit would imply a dynamic adjustment from misfit(fit) to fit(misfit) that would require longitudinal data. There is therefore a limitation that is inherent to the cross-sectional design of the survey study. In addition to this empirical constrain, the model about determinants of EPMs use posited a *congruence/mediation* type of fit between environmental-related strategic choice, design and use of environmental performance measures in formal management accounting systems. The selection or mediation concept of fit in traditional contingency research rests on the assumption of optimisation between context and structural variables (cf. Donaldson, 2001). Under this assumption, Gerdin and Greve (2004:307) concur that:

> *"There is no need to test the link with performance, since it is (implicitly) assumed that fit is the result of a natural selection process that ensures that only the best-performing organizations survive to be observed at any point in time".*

One controversy of the congruence type of fit is therefore the absence of a formal testing of performance effects that proves the presence of fit-misfit situation in selection type of models. In this respect, Pennings (1992:274) notes that:

> *"signalling survival of the fittest is too crude a proxy for performance".*

The paradox of empirically testing congruence/mediation type of fit propositions translates into (1) the *ex ante* assumption that context and structure variables should be aligned, associated with (2) the *ex post* expectation that context and structure should not be aligned to allow detecting fit-misfit situations in performance levels, and coupled with (3) the impossibility to formally test (static) performance effects since this would imply an interaction model between context and structure that is conceptually different from the mediation model initially postulated (cf. a discussion on the reverse argument occurring in moderation type of contingency models presented in Hartmann and Moers, 2004, Greve, 2005 and Hartmann, 2005). Stated differently, if one aims to provide empirical evidence about the underlying rationale of congruence propositions, at the same time needs to contradict the model specification due to the impossibility of testing performance effects with mediation type of models. As emphasized by Fry and Smith (1987:122), the assumption of congruence fit is a necessary but not sufficient condition for contingency fit. In this respect, the problem of combining theory-driven corroborations of mediating-models and, on the other hand, legitimate calls for statistically appropriate tests of misfit/fit in cross-sectional studies have received little emphasis in contingency-based literature, both in management accounting research (cf. Luft and Shields, 2003, Gerdin, 2005a, 2005b, Gerdin and Greve, 2004, and Hartmann, 2005) as well in organizational research (cf. Schoonhoven, 1981; Fry and Smith, 1987; Donaldson, 2001).

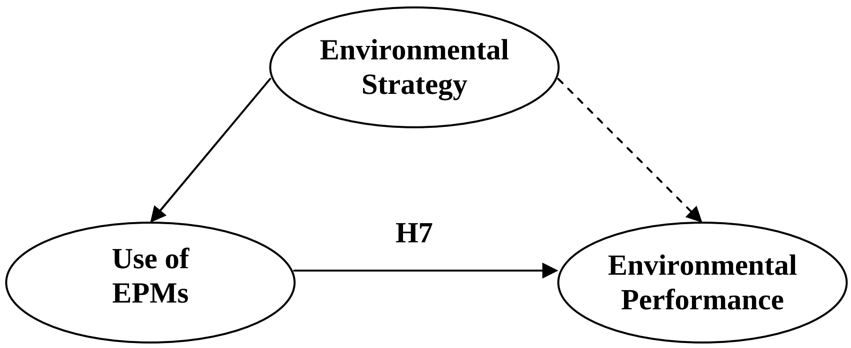
In this study a *contingency/mediation* specification model was explicitly chosen to explore performance effects of performance measurement systems. In line with the model on determinants of EPMs developed in the previous section, it is expected that environmental strategy positively affects the use of EPMs for internal control (Hypothesis 1). Performance measurement systems for environmental management are therefore assumed as endogenously determined rather than independent, exogenous variables. As such, there is no theoretical justification to rely upon a moderation fit model as the use of EPMs is conceptually dependent upon environmental strategy (Ittner and Larcker, 2001; Hartmann and Moers, 2003). Hence, I maintain that a *contingency/mediation* specification model corresponds better with theory to test contingency relationships in this study.

The consequences of environmental strategy through the intervening use of EPMs for internal control will be explored with regards to the dependent variable labelled as environmental performance. The construct *environmental performance* captures multi-dimensional aspects related to the organizational impacts of business activities on the natural environment (cf. discussion presented in Section 2.2.1). The choice of environmental performance as dependent variable makes the setting even more problematic in light of controversies surrounding contingency theory previously summarized. Can we draw a parallel between notions of organizational performance from contingency-based research with environmental performance? Strictly related to this issue, notion of equilibrium and equifinality in this area posits also crucial questions to underlying theory. Another empirical issue regards empirical test for performance effects of fit. Venkatraman (1989:430) emphasized that *“the usefulness of a mediation perspective depends on availability of the test statistic for the effects of fit”*. Fortunately, as discussed in Chapter 5, recent developments in psychological methods allow formal, statistical corroboration of indirect or mediating effects, providing feasible ways to initially tackle the intricacies in contingency-based research.

Prior empirical literature provides some preliminary evidence regarding the positive relationship between the use of EPMs in formal management control systems on environmental performance through mediating effects of management control systems. A few papers in management accounting have examined and empirically detected the intervening role of EPMs on environmental performance as reviewed in Chapter 2 (Epstein and Wisner, 2000; Wisner *et al.*, 2002). Similarly, some empirical studies in the environmental management area developed intervening model approaches by focusing on a few aspects of environmental strategy or management control systems (Judge and Douglas, 1998; Klassen and Whybark, 1999a). However, these studies posit less complete relationships in the model investigated than the model proposed in this study.

In conclusion, it can be expected that the use of EPMs is positively associated with environmental performance indirectly through the use of environmental performance measures for internal control. The following hypothesis will be tested as depicted in Figure 3.2:

Figure 3.2 – The conceptual model about effects of EPMs use



H7: *There is a positive indirect relationship between environmental strategy and environmental performance through the use of environmental performance measures for internal control.*

3.4 Summary

This chapter integrated insights from different literature to develop hypotheses concerning performance measurement choice in the area of environmental management. I examine the relationships between environmental strategy, design and use attributes of environmental performance measurement systems through a set of testable propositions summarized in Table 3.4. In the remainder of this dissertation, Chapter 4 presents the survey design and Chapter 5 will report and discuss the empirical test of the hypotheses. As explained in Chapter 2, Chapter 6 will subsequently build upon the survey results to develop an illustrative case study that will address the same hypotheses formulated in this chapter.

Table 3.4 – Summary of hypotheses

Hypotheses	***Predicted sign***
H1a: ENV_STR → USE_EPM_INT	Positive
H1b: ENV_STR → USE_EPM_EXT	Positive
H2a: ENV_STR → EMIS_AVA	Positive
H2b: ENV_STR → EMIS_SCO	Positive
H2c: ENV_STR → EMIS_TIM	Positive
H2d: ENV_STR → EMIS_ACC	Positive
H3a: EMIS_AVA → USE_EPM_INT	Positive
H3b: EMIS_SCO → USE_EPM_INT	Positive
H3c: EMIS_TIM → USE_EPM_INT	Positive
H3d: EMIS_ACC → USE_EPM_INT	Positive
H3e: EMIS_AVA → USE_EPM_EXT	Positive
H3f: EMIS_SCO → USE_EPM_EXT	Positive
H3g: EMIS_TIM → USE_EPM_EXT	Positive
H3h: EMIS_ACC → USE_EPM_EXT	Positive
H4a: ENV_STR →EPM_SEN	Positive
H4b: ENV_STR → EPM_PRE	Positive
H4c: ENV_STR → EPM_CON	Positive
H5a: EPM_SEN → USE_EPM_INT	Positive
H5b: EPM_PRE → USE_EPM_INT	Positive
H5c: EPM_CON → USE_EPM_INT	Positive
H6: *Environmentally proactive* companies use EPMs more consistently than *reactive* companies	Significant difference
H7: ENV_STR → USE_EPMs → ENV_PER	Positive indirect effect

Endnotes Chapter 3

[1] The concept of a nomological network was developed by Lee Cronbach and Paul Meehl in 1955 in response to the American Psychological Association's efforts to standardize psychological testing (Cronbach and Meehl, 1955). This network consists of the theoretical basis of what researchers are trying to research, a logical framework of how researchers conduct the research, and the specific connections between the theoretical background and the research construct. The basic idea behind this conceptualization was to try and establish a possible methodology to link the theoretical sphere with the observable one.

[2] Endogeneity is caused whenever a predictor is also a choice variable that is correlated with the random error in the structural model. This misspecification causes the parameter estimates to be inconsistent, which renders the interpretation of the model and hypothesis tests problematic (cf. Ittner and Larcker, 2001:397; Chenhall and Moers, 2004).

[3] A distinction can be drawn between environmental *metric* and environmental *indicator* (Graedel and Allenby, 2002). A metric is a quantitative measure of performance relative to a defined criterion. An indicator is a non-quantitative measure of environmental state, such as the existence of an endangered species.

[4] A separate stream of research in environmental economics employs principal-agent model to analytically examine the relative efficiency of different penalty schemes (civil liability of the corporation versus civil liability of individual managers, criminal sanctions taken against individual managers). Segerson and Tietenberg (1992) analytically present an application of the structure of penalties to the specific problem of environmental enforcement.

[5] A similar argument is advanced by practitioners' literature in management accounting about the necessary modification of compensation and reward systems to allow the integration of environmental issues into "traditional" business activities (Epstein and Wisner, 2001; Kaplan and Norton, 2003).

[6] Prudence refers to the propensity to prepare and forearm oneself in the face of uncertainty, in contrast to risk aversion, which is how much one dislikes uncertainty and would turn away from uncertainty if possible. In the model proposed by Sinclair-Desgagné and Gabel (1997), prudence entails that the agent would shelter against risk by choosing an allocation effort that increases his average income, while risk aversion implies that the agent would rather tend to distribute his effort in order to lower the probability of the worst outcome.

[7] Consistently with the assumptions of principal-agent framework, the firm is viewed as a "black box" and decisions taken at managerial levels are treated as if taken by a single agent that represents the whole organization.

[8] With a Cartesian approach, the research focus is to examine how contextual factors affect single structural attributes and how these context-structure pairs affect performance (Drazin and Van de Ven, 1985). In line with the tradition of reductionism, it is assumed that a limited number of contingency factors explain organizational structure (Gerdin and Greve, 2004). Furthermore, contextual as well structural factors are defined as continuous variables and "*fits*

between them are also continua, there being many points of fit" (Donaldson, 2001). Cartesian approach can be contrasted with a Configuration research approach. The holistic view held by the Configuration school opposes partial analysis of context and structure variables. Relationships can be only understood if many contextual and structural variables are analyzed simultaneously (Drazin and Van de Ven, 1985).

[9] Refer to Lewis and Harvey (2001) for a "translation" of the *perceived environmental uncertainty* (PEU) variable into the domain of environmental management.

[10] Different forms of fit have been defined and some conceptualizations of fit seem even not comparable (Drazin and Van de Ven, 1985; Venkatraman, 1989). For a debate on the concept of fit and the implications for testing *congruence* versus *contingency* models in management accounting research refer to Gerdin and Greve (2004), Gerdin (2005a, 2005b) and Hartmann (2005).

CHAPTER 4

SURVEY RESEARCH METHOD AND DESCRIPTIVE STATISTICS

4.1 Introduction

This chapter describes the research method used to collect survey data about use and effects of environmental performance measures in a sample of different manufacturing companies located in The Netherlands. It presents the survey design and the item analyses of the instruments used in the questionnaire. Furthermore, the chapter contains a preliminary analysis of the data obtained with the questionnaire, before performing the statistical analysis of the hypotheses in the next chapter. The chapter is structured as follows. Section 4.2 describes the rationale behind the design of the questionnaire within a broader research project carried out in collaboration with the Dutch Chartered Institute of Management Accountants (*Controllers Instituut*, abbreviated in this dissertation with the label "CI"). Subsequently, it illustrates the sample selection regarding companies and CI members. Section 4.3 describes the steps taken in the composition, pretest and administration of the questionnaire. Section 4.4 then discusses the measurement instruments included in the questionnaire. Further, Section 4.5 presents a preliminary analysis of the results and item reliability analyses of the measurement instruments. Section 4.6 reports descriptives and univariate analyses of the results. Section 4.7 contains tests for potential bias from non-response. Finally, Section 4.8 summarizes survey research design and draws conclusions from the preliminary data analysis.

4.2 Survey design

4.2.1 The study within the project "Performance Management in The Netherlands"

This study is based on data collected from a survey among members of the CI employed in different manufacturing companies located in The Netherlands. The *Controllers*

Instituut was founded in 1994 as a joint-effort between *VRC* (the Dutch Association of Chartered Controllers) and *FINAD* (the Dutch Association of Chartered Accountants), with the objective of increasing the quality of the professional level of Chartered Accountants and Chartered Controllers in The Netherlands. The Institute works towards this goal by organizing continuing professional education for financial executives. The survey was one of three separate questionnaires administered by the University of Amsterdam and Nyenrode University within the research project *"Performance management and the role of the controller in The Netherlands"*. The research group consisted of two professors in Management Accounting and three Ph.D. candidates in Management Accounting. The CI sponsored the investigation of three topics within the research project in order to get empirical insights about current developments concerning management accounting and control practices in Dutch organizations. Apart from this study, one research project focused on the role of the controller's function, while the other investigated the effects of performance measurement systems on managerial time orientation. The project was the first of its kind in The Netherlands addressing the population of controllers and financial managers employed in Dutch companies. Given the absence of data over use and effects of performance management systems in The Netherlands, this topic was chosen as a central research theme from a review of extant professional literature and recent international surveys of practice (e.g. IMA, 1999; IFAC, 2001; CIMA, 2003). The theme was also identified as a topic of discussion during the fifteenth anniversary of the Institute that was to be held four months after the data collection was carried out. A brief article written by the research group before the survey was administered explained motivation and objectives of the research project. The goal was to raise the interest among the population of controllers with respect to issues concerning, among others, the design of performance measurement systems or recent innovative management accounting practices. The article was published in the professional journal bimonthly distributed by the CI (*MCA – Management Accounting and Control*) one month in advance to the administration of the questionnaires (Bouwens, Hartmann, Maas, Perego and van Rinsum, 2003a). The three areas/topics addressed by the independent survey projects were not explicitly mentioned in the article. A generic announcement was instead stated in the article, pointing out that a questionnaire would have been distributed to a selection of CI members in a few weeks time.[1]

It is important to emphasize that contentwise the three questionnaires addressed different research questions. Nevertheless, all three questionnaires presented a similar layout and contained a common part in which data deemed of interest to the three studies were collected. The administration of the surveys occurred simultaneously for the three questionnaires, following the same procedures and using the same stationery material. The sampling selection among the CI members was carefully executed in order to allocate an individual respondent to one and only of the three questionnaires. In the following section, I will discuss critical aspects behind the choice of the research design and sampling method. Further, Section 4.2.3 presents the criteria regarding the selection of participating organizations and respondents from the CI membership list.

4.2.2 Introductory remarks on research design and sampling method

The choice of implementing the questionnaire under the sponsor of a "legitimate authority" is not new in management accounting (e.g. Stone, Hunton and Wier, 2000) and it is in line with the recommendations of the *Total Design Method* (TDM)[2] proposed by Dillman (2000) for survey-based research. Prior studies have shown that people are more likely to comply with a request from an authoritative source (Dillman, 2000). Relying upon a legitimate sponsorship was considered as an attempt of controlling – and possibly reducing – the non-response problem associated with the survey method. It appears from recent research that organizational respondents are likely to require higher incentives to affect their participation in a survey, due to the competing demands placed on respondents' working day, the value they place on their time, and their perception of the value of the information to themselves and the survey sponsor (cf. Jobber, Saunders and Mitchell, 2004). Additional reasons to opt for the sponsorship were that the study was presented as of practical significance for the participating members and one of the first of its kind at the country level. These aspects were supposed to enhance the respondents' willingness to participate in the research project. Finally, the CI made available financial provisions and stationery material that are necessary elements during the implementation phase of the survey.

With regards to the *sampling* method, it is important to acknowledge the *exploratory* nature of this study, given the novelty of the field and the scant research available in academic literature on the topic. Under these circumstances, I adopted a *non-random* purposive sampling instead of a fully random sample. Specifically, I opted for a *judgment* sampling method (cf. Cooper and Schindler, 2001:201) because, as I will illustrate in Section 4.2.3, sample members were selected to conform to some specific criteria. A related issue concerns the use of members of an accounting professional institution as potential respondents to a survey focused on a topic that can be expected *a priori* as non-accounting-related. A sample of CI members was used as respondents to elicit information about the performance measurement and control systems currently in place in their companies. The study thus does not address organizational functions that are potentially more acknowledgeable over environmental management and environmental accounting practices (like, for instance, environmental managers, quality managers, or manufacturing managers). The choice of relying upon the financial manager as competent respondent was justified by the purpose of getting insights about the extent of integration of environmental issues in traditional management accounting and control practices. Anecdotal evidence concerning the role and involvement of accountants and controllers in these practices is particularly limited (cf. Gray *et al.*, 1995; Medley, 1997; Lodhia, 2003). The aim therefore was to address controllers or other financial managers with the clear objective of assessing whether and how “greening” had affected the design of MCS and the scope of controllers’ functions. It was believed that the use of a respondent with a financial/managerial expertise would have ensured less biased information concerning environmental-related information, particularly when compared to alternative organizational members whose function is more directly associated with environmental management. On the other hand, it must be acknowledged that this choice increased the risk of addressing a respondent with a potential scant awareness or familiarity about the topic object of research. The alternative choice of addressing two respondents (a financial manager in combination with a function expected to have more environmental-related expertise) was not taken into consideration for this study. This choice would have meant requiring and obtaining the list of a suitable respondent for each respondent in the sample.

4.2.3 Sample of organizations and respondents

The selection of the organizations and respondents was based on a membership list provided by the CI. As for 2002, the members attached to the CI list amounted to about 5,800 professionals. Members with the RC title are, on average, younger than members with the RA title since the professional certification of chartered controller was introduced in The Netherlands in 1990. The membership list contained name, company name and functional occupation, together with the private address of the CI members. With regards to the sampling method used in the survey, three criteria were followed after a careful scrutiny of the CI membership list. First, I included companies located in The Netherlands and respondents resident in The Netherlands. Companies located abroad and respondents registered with a foreign address were not considered. Though the study was designed at the organizational level of analysis and no instrument was developed at the individual level, this choice allowed controlling for the potential bias from national factors (e.g. regulatory regime about environmental protection) influencing the topic under study. Second, the companies were selected on the basis of their industrial code: only respondents from manufacturing sectors (SIC-code between 0 and 50) were included in the sample. The reason to exclude companies in the financial sector or service companies was that the availability and use of environmental performance measure were expected *a priori* to be limited, if non-existent, for these organizations. By including only industrial organizations, I expected to find enough variation in environmental management and environmental accounting practices, while at the same time reducing the risk of not finding empirical evidence of the phenomenon object of study (cf. Choudhoury, 1988). On this issue, some additional considerations are presented in the study limitations section contained in Chapter 5. Third, the size of the companies was used as a sample criterion. For the same reason mentioned before (i.e. reduction of the likelihood of not finding the phenomena object of research in the population under scrutiny), I opted for companies above a certain number of employees. In order to ensure that the two samples of the other two surveys in research project contained a representative number of respondents from manufacturing companies, the size of companies selected was initially above 250 employees. However, after comparing the list of respondents with the two preliminary samples formed by the two other surveys in the research project, the criterion was modified and companies above 100 employees were included to obtain an acceptable sample size. In sum, the choice to reduce the size to 100 employees was due to the constraints of the survey project, in which three independent questionnaires needed to include a representative amount of respondents employed in the manufacturing sector as provided by the CI membership list. Besides, it was expected that firms with fewer than 100 employees were unlikely to have clearly defined areas of responsibilities and a formalized management accounting and control system (Brownell and Dunk, 1991).

Given these general criteria, I describe next the steps undertaken in the selection of the sample of organizations and respondents. The first step consisted in identifying manufacturing companies located in The Netherlands using data available from a financial database.[3] Dutch companies operating in manufacturing sectors (i.e. with SIC-code from 0 to 50) and with more than 100 employees were first identified and matched with the companies contained in the CI membership list. As a result, a total number of 1.392 companies were initially selected and matched with a sub-sample of the CI membership list. The sub-sample was compiled by excluding the following functions: member of Board of Directors, CEO/CFO, Vice President, Group controller, Concern controller. The reason behind this choice was that the study aimed to examine relationships preferably at the divisional or operational level of analysis. Also other functions were excluded, in particular consultants or professionals that were not attached to a specific company. Even though I was not able to select *a priori* the level of analysis, sampling was then executed by giving preference to the following functions: first, controllers or management accountants; then plant controllers; followed by financial or general directors. In principle, the selection of the respondents included one respondent per organization, except for multidivisional companies belonging to concerns of large dimensions in which one respondent per division was selected whenever possible. The division was recognizable by the name of the company and the division (or Business Unit) available in the membership list provided by the CI. In case of multiple potential respondents employed in the same company or division, the respondent with the function title of *controller* was eventually chosen. In case of similar titles, the choice was randomly made.

In selecting the respondents, I additionally attempted to include organizations that were included in a list of companies subject to a mandatory environmental reporting law. Under the *Environmental Management Act 1993*, a Dutch regulation was introduced in 1997 and enforced from 1999, which imposed new statutory reporting requirements on Dutch companies judged to have serious adverse effects on the natural environment (Drieënhuizen, 2001; Kolk, 2002; Hibbitt and Collison, 2004). The introduction of the statutory environmental reporting had different purposes, including the promotion of environmental management systems, the increase in corporate accountability and the harmonization of various environmental reporting formats to the governmental authorities. The regulation applies to production units (operating sites) only and not companies activities as a whole. Specifically, the decree applies to approximately 250 production sites from 150 different companies. The regulation is enforced for industrial sectors which are considered to impose a heavy environmental burden, including for instance chemicals, base metals, power generation and waste incineration facilities (the complete list of facilities subject to the decree is available at Enviroreporting, 2004). These facilities are prompted to publish two types of environmental report, each for a specific audience: 1) a report to the governmental authorities (copies of which are available to interested parties on request); 2) a report to the general public, the latter to be released in accordance with certain procedures. The reports submitted to the governmental authorities are quite detailed and include the provision of information on emissions, on soil pollution and the company's policy on environmental management. The public reports are much less detailed and the content is largely left to a company's willingness to disclose information. As a minimum, the decree requires that the public report shall be formulated concisely and in a manner that is intelligible to the general public. The public report is intended to inform all stakeholders including local residents, employees, business partners and environmental organizations. It must also contain a description for the reporting year of the nature of business practices that are relevant to the environment, concerning for instance relevant quantitative data over production and administrative processes.

In selecting the respondents, it was not always possible to determine beforehand whether a respondent could be associated to the mandated facility. For instance, a controller employed in a chemical company could be responsible for the performance measurement and control systems of multiple production sites, some of which are actually mandated while others not. For this reason, in the questionnaire it was explicitly required to indicate whether the organizational unit of reference disclosed environmental information through a voluntary versus a mandatory environmental report (if any).

On the basis of this preliminary selection, a comparison with the samples formed by the other two researchers was subsequently carried out. The comparison was deemed necessary to ensure that (1) a respondent would have not be included in two different sample lists, and (2) the other two samples would have contained enough respondents employed in manufacturing companies.[4] After an accurate crosscheck with the other two sample lists of the research project, a total of 285 contacts were included in the final sample.

In summary, the size and composition of the sample was eventually determined by four factors: (1) the composition of the membership list provided by the CI, in which the majority of members are employed in non-manufacturing sectors; (2) the function occupied by the CI members as reported in the membership list; (3) the attempt to include a number of respondents employed in organizations subject to a mandatory environmental reporting scheme enforced in The Netherlands; and (4) the need of allowing the identification of enough sample size for two other studies that selected the respondents from the same population of CI members. In absence of the latter condition, the sample size could have been expanded to comprise a higher amount of respondents. Descriptive statistics about the final composition of the sample is presented further in Section 4.5.1 and Section 4.5.2.

4.3 Questionnaire design

4.3.1 Choice of language of the questionnaire

Despite of the fact that several of the instruments were adapted from the Anglo-Saxon literature, the language used in the questionnaire was Dutch. Different reasons explained this choice. First, in terms of willingness to participate to the survey, the use of a Dutch, translated, questionnaire was considered a better option than an English text. The study was presented as a national research project over performance management, sponsored by the Dutch *Controllers Instituut* among companies located in The Netherlands. Second, the differences in knowledge of English texts within the population were believed to pose a threat to the reliability of the response. Third, the use of a Dutch questionnaire provided the possibility to use a terminology more appropriate to the Dutch context, especially with regards to some terms referring to environmental issues.

4.3.2 Translation, composition and pretest of the questionnaire

The design of the questionnaire required several steps. As a first step, the instruments were developed or adapted from existing literature. A draft version in English was circulated among the members of my research group and object of several revisions, in particular with respect to the environmental-related constructs. A Dutch native speaker with expertise in translation from English texts then prepared a first draft version of the questionnaire. This draft version was submitted back to the scrutiny of the members of the research group. In particular, the two professors in Management Accounting that coordinated the research program thoroughly examined the questionnaire and provided major comments. Additionally, four academics (one professor, one lecturer and two Ph.D. students) specialized in the area of environmental management examined the questionnaire and gave comments. All the persons involved were Dutch native speakers. They were requested to provide critical comments on the wording and the understandability of questions and individual items, but also on the layout and the sequence of the questions. As most of the instruments were newly developed, the comments received were extremely valuable to ensure satisfactory content validity to the measurement instruments. After receiving written comments on the first draft, several adjustments in wording or in the sequence of the sections were made and a second draft of the questionnaire was then prepared.

In the subsequent phase, the second draft version was pre-tested with two Dutch senior managers (one employed as controller, the other as environmental manager) employed in manufacturing companies. Written comments were received by post and incorporated in the questionnaire. The draft was also pre-tested by four assistant controllers that participated in a post-graduate course leading to the obtainment of the RC title organized at the University of Amsterdam. The pre-test was conducted by asking for voluntary participation during one session of the course after a brief illustration of the research project's objective. The volunteers were provided the questionnaire and asked to fill it out in presence of the researcher. The purpose was to test whether the questionnaire was understandable, attractive and easy to fill out. In addition, it was necessary to estimate the time needed to complete it. The participants were asked about these aspects after everyone completed the questionnaire. Further adjustments in the wording of the questions and the items were necessary to increase clarity and understandability. Eventually, the final phase of the questionnaire design consisted in minor changes to the phrasing and order of some of the questionnaire's items.

4.3.3 Final format and layout of the questionnaire

The preparation of the final mail-out package was made in accordance with the *Total Design Method* proposed by Dilmann (2000). A separate cover letter printed on high quality stationery with the CI logo was attached to the questionnaire, with a brief explanation of the research project and the reference to the article published in the professional journal. The participation to the study was solicited to provide relevant insights of current practices that were expected to be useful for the professional improvement of the respondents. The letter also guaranteed anonymity of responses, explaining that no individual response would be disclosed or reported to any third party, including the CI. The letter ended with a statement of appreciation, the full address and a handwritten signature of the researcher.

The final version of the questionnaire was a twenty-four-page booklet in A4 format digitally printed in black and white on high quality paper. On the front cover page of the booklet, a title ("Environmental Management Control"), a sub-title ("*Milieuprestatiesystemen*", i.e. "Environmental Performance Systems") and the logos of the *Controllers Instituut*, the University of Amsterdam graduate Business School and the Nyenrode University were displayed. The first two pages of the questionnaire contained a brief explanation of the study's objective, the contents of the questionnaire and the instructions to fill out the survey. It was also stated that filling out the questionnaire would have taken approximately thirty minutes. Name, address and additional contact information of the researcher were given in case of additional information was required. In order to better specify the meaning of some terms used in the survey, some definitions were provided at the beginning of the questionnaire. First, as the questions were questions were formulated with reference to the respondents' "organizational unit" ("*bedrijfseenheid*"), a definition was given as follows:

> *The organizational unit refers to the part of the organization where the respondent is attached and in which his/her tasks are applied.*

A few definitions of environmental-related terms were furthermore added in order to add clarity to those respondents that were expected not to be familiar with the terminology used in the questionnaire.[5] In ordering the questions, it was chosen to group together those items with similar contents. An attempt was made to build a sense of flow throughout the questionnaire by the order of the questions and the layout of the answers. The questionnaire was structured in four sections clearly introduced by a sub-title:

- Section I: Questions about the environmental performance measurement system;
- Section II: Questions about the organizational unit and the company;
- Section III: Questions about the function of the respondent;
- Section IV: Questions about personal data and incentive system.

Section III and Section IV were designed as the common parts of the three questionnaires. No reference was made to the relationships being tested or to the variables measured in any part of the questionnaire. At the very end of the questionnaire, the respondent was invited to indicate her/his preference about receiving a report with the results of the study. The last page of the booklet was left blank to give the respondents the opportunity to express their opinions about the questionnaire. At the end, the back cover page of the booklet contained a space in which I assigned a progressive number to each respondent in the sample with an explicit statement that the coding procedure was for administrative purposes only and that anonymity would be maintained. The coding procedure thus allowed the questionnaires to be traced back and non-respondents detected for the follow-up mailing and round of telephone calls.

4.3.4 Distribution of the questionnaire and follow-up

The complete package contained the cover letter, the questionnaire booklet, a stamped return envelope and a token of appreciation. A meta-analysis performed by Church (1993) on the effect of incentives on mail survey response rates indicated that it is incorrect to assume that any reward used in a survey will result in improved response rate. Rather, only incentives provided with the initial mailing of the survey instrument had a significant positive impact on response rates. The meta-analysis revealed that the use of monetary rewards for completing surveys had the most significant impact on increasing response rate. Adequate support was also found for including non-monetary incentives with the initial mailing (an additional 7.9% average increase in returns over control conditions). For this survey, the research team opted for a token of appreciation for two reasons. First, the budget available would have allowed a financial incentive of limited value, in particular when considering the managerial position occupied by most of respondents.

Second, the token of appreciation (a ballpoint pen) was carefully selected and personalized with the CI logo. The package was sent out by postal mail using quality stationery provided by the CI. The respondents received the package at their private address, as this was the address provided by the membership list. Approximately after three weeks following the distribution, a postcard thank you/reminder was sent to everyone in the sample. The postcard thanked those who returned the questionnaire and contained an invitation to fill out the questionnaire for those who did not participate. The postcard displayed the logo of the CI, contained a statement of appreciation and the researcher's name, address and handwritten signature. The subsequent step consisted in preparing a replacement mail-out package. It consisted of a follow-up letter, the questionnaire booklet, a stamped return envelope and a copy of the article published in the professional journal. As token of appreciation, the ballpoint pen was not sent again. Instead, it was opted to insert a copy of the article published in MCA that highlighted research objectives of the national survey about performance management. The package was distributed to those who did not respond to the survey and was distributed after two weeks the postcard reminder was sent out. The letter restated the objective and relevance of the research project, and invited the recipient to fill out the questionnaire.

Finally, with a lapse of three weeks after the distribution of the replacement questionnaire, a final effort to elicit a response from non-respondents was made by telephone. A script was prepared and used during the telephone calls by a Dutch native speaker who was carefully instructed about the tone to be used. The round of telephone calls aimed primarily to encourage the non-respondents to complete and return the questionnaire. In addition, the telephone follow-up aimed at collecting evidence about the ineligibility of the respondents (see Section 4.5.1). The round of telephone calls lasted approximately six weeks as it was performed in the holiday's period in The Netherlands. As I will illustrate in more detail in Section 4.5.1, a problem emerging during the data collection and telephone follow-up was related to the differences indicated by some respondents with regards to their actual occupation. It appeared soon after the administration of the questionnaire that the membership list made available by the CI for the sampling procedure was not updated. As a result, a rather significant percentage of potential respondents were not eligible since they indicated to have moved away from their previous employer in manufacturing sectors towards companies in non-manufacturing sectors.

In conclusion, the design of the questionnaire followed the procedures of the *Total Design Method* approach proposed by Dillman (2000) in an effort to maximize quality and quantity of response. In particular, the survey was developed to reduce measurement error that could have resulted from poor wording or inaccurate answers. I explicitly addressed a survey population of controllers and financial managers to gain insights about current practices of environmental management and environmental accounting. In addition, I relied upon the sponsorship of a professional accounting institute to gain interest and higher participation from the respondents.

4.4 Measurement instruments

Most of the instruments used in the questionnaire to test the hypotheses derived in the previous chapter were newly developed for this study, since there are no established constructs in the literature about the variables investigated. Whenever possible, I attempted to identify instruments used in prior survey studies and adapt them to the empirical setting. The remainder of this section discusses the choice and composition of the instruments to measure the variables. It also presents some additional variables or items that will be used to complete the analysis for a descriptive analysis or for construct validation purposes. Appendix C presents the items included in the questionnaire for each measurement instrument. Item analyses and descriptive statistics will be presented in Section 4.5 and 4.6.

Environmental strategy

The literature in operations management and in strategic management provides recent attempts to measure the strategic positioning of the firms in relation with their environmental practices. Variation exists in the constructs foci and number of items developed. As a result, no consistent and commonly accepted definition of environmental strategy is currently available. In this study, I rely upon the review of representative studies presented in Section 2.2.1 where the main instruments about environmental management typologies were evaluated. To measure *environmental strategy* (ENV_STR), I first explore two dimensions of corporate environmentalism drawing upon the items available in Banerjee (2002a) and Banerjee, Iyer and Kashyap (2003). These recent studies differentiate a measure called "corporate environmental orientation" from an instrument labelled as "environmental strategy focus". The latter reflects the degree of integration of environmental issues into the strategic planning process, while the former refers to the notion of corporate responsibility towards the environment[6] (Banerjee, 2002a:182). Both dimensions attempt to elicit information concerning underlying *principles* of environmental management that companies tend to formalize in mission statements. I have therefore identified from the instruments in Banerjee (2002) and Banerjee *et al.* (2003) nine items (from ENV_STR1 to ENV_STR_9) expecting a unique factor underlying environmental concerns of organizations at the strategic level (cf. Table C.1 in Appendix C). Sample statements for this instrument measured on a five-point fully anchored scale are: "*My company has a clear mission statement urging environmental awareness in every area*"; and "*In my company, environmental goals are linked with other corporate goals*". The second dimension to capture ENV_STR refers to the *practices* of environmental management and reflects prior instruments taken from Melnyk, Sroufe and Calantone (2003) and other empirical studies in the environmental management area (Aragon-Correa, 1998; Judge and Douglas, 1998; Sharma and

Vredenburg, 1998; Klassen and Whybark, 1999a; Nakamura *et al.*, 2001; Roy *et al.*, 2001; Buysse and Verbeke, 2003). The items (from ENV_STR10 to ENV_STR_21) aim to capture the extent to which the environmental aspects of operations are recognized by managers and integrated in their firms' management systems. I attempted to address different aspects of environmental management by adapting the classification by Merchant and Van der Stede (2003) of *personnel controls* (items ENV_STR1, ENV_STR2, ENV_STR3, ENV_STR6 and ENV_STR7) and *action controls* (items ENV_STR5, ENV_STR9, ENV_STR11) to the environmental management area. Respondents were asked to indicate, on a five-point Likert scale, the agreement on statements like: *"My unit implements employee involvement type programs (e.g. like quality circles or suggestion programs) that explicitly include environmental management aspects"*; and *"Standardized procedures are in place to include environmental aspects in the capital budgeting process"*. Overall, the practices addressed aim at obtaining a broad "package" of management instruments or techniques that companies develop to implement their environmental strategy. In fact, the final score of the instrument ENV_STR consists of an aggregated version of the two instruments after refinement from reliability analysis. The combined instrument was expected to have higher construct validity than either of its two constituting instruments. Furthermore, the aggregation of several items to measure environmental strategy was expected to enhance the reliability of the instrument. Concerning the level of analysis, I will make no distinction between corporate, business or operational level of analysis. Instead, the main concern here is to create a multi-item measure of environmental strategy that will be further subject to an exploratory factor analysis in Chapter 5 to assess its (convergent and discriminant) validity properties.

Sophistication of environmental information system

Four dimensions or attributes of a management information system were measured. First, I developed the variable *availability* (EMIS_AVA) that aims to elicit information about the perceived *actual* development of environmental performance measures in a respondent's organizational unit. The variable is measured with an instrument similar to the variable labelled as "development of performance measurement" that Cavalluzzo and Ittner (2004) created for performance measures in the public sector. The variable differentiates between non-financial versus financial environmental performance measures available along five typologies that are contained in the ISO 14031 standard that proposes a classification of environmental performance indicators (ISO, 1999). ISO 14031 defines environmental performance evaluation as *"an internal management process and tool designed to provide management with reliable and verifiable information on an ongoing basis to determine whether an organization's environmental performance is meeting the criteria set by the management of the organization"* (Marshall and Brown, 2003). This standard gives guidance on the design and use of environmental performance evaluation within organizations of any type, size, location or industry. Environmental performance evaluation involves selection of environmental indicators, development of performance criteria related to those indicators, and then a comparison of the organization's actual performance with those criteria. The standard does not establish environmental performance levels, nor is intended for use as a specification standard for certification or registration purposes or for the establishment of any other environmental management system conformance requirements. The respondents were required to evaluate the extent to which quantitative or qualitative information is available in their organizational unit with regard to five categories of performance measures: resource, output, efficiency, impact and management performance measures respectively (cf. Table C.2 in Appendix C). Answers were elicited by using a five-point Likert scale by referring first to these five dimensions in *non-financial* terms (items from EMIS_AVA1 to EMIS_AVA5). The same dimensions were therefore assessed in *financial* terms (items from EMIS_AVA6 to EMIS_AVA10). The basic rationale behind this instrument is that the same performance measure can be assessed in physical terms (for instance, quantity of solid waste disposed for the category output performance measure), while a monetary value can be attached to the same metric (following the previous example, the costs associated to waste collection, transport and disposal). Examples of performance metrics for each category were given to elucidate the meaning of the categories to the respondents. The examples were drawn from a selection of performance measures that were listed in a selection of recent guidelines prepared for the implementation of environmental management accounting (e.g. GEMI, 1995; IFAC, 1998; WBCSD, 2000; United Nations, 2001; GRI, 2002), corporate sustainability reports considered among the most exhaustive in the area of environmental reporting and popular business articles (e.g. Bennett and James, 1998a; Epstein and Wisner, 2001; Burritt *et al.*, 2002). Table D.1 in Appendix D summarizes the main dimensions from prior studies or environmental reports that were used to operationalize the instrument for the environmental performance measures. A distinction in the table is made between environmental performance measures expressed in *non-financial* versus *financial* terms.

Second, a series of items aiming at measuring different dimensions of an environmental information system were adapted from the instrument proposed by Chenhall and Morris (1986). The variable EMIS *scope* (EMIS_SCO) was constructed using three items partially following Pondeville (2003). The instrument referring to EMIS *timeliness* (EMIS_TIM) intends to measure the frequency and speed of reporting tailored to the environmental context (cf. Table C.3 in Appendix C). Two items from Chenhall and Morris (1986) were adapted for this purpose. Finally, EMIS *accuracy* (EMIS_ACC) was measured by adapting the instrument developed by Moers (2001) using four items addressing the perceived verifiability and objectivity of the environmental performance measures.

It is important to emphasize two aspects inherent to measurement choice. First, the scores inherent to the four dimensions of EMIS sophistication were elicited asking the respondents to indicate their opinion about the environmental performance measures to be considered as a whole. This choice does not allow disentangling potential differences in the four dimensions across the categories of performance measures that were addressed by the instrument *availability*. Second, the four dimensions were separately measured and were not aggregated in a variable (EMIS sophistication) to allow for testing of separate casual paths. An alternative model specification could have been explored, using EMIS sophistication as a second-order formative construct that comprises the four attributes. Theoretically, this choice needs to be supported by strong theoretical arguments that permit to fully characterize the formative indicator measurement model (cf. Burke Jarvis, Mackenzie and Posdakoff, 2003).

Environmental performance measure properties

I attempted to examine performance measures properties from economics-based analytical research using proxies that are psychometrically measured. As noted by Gibbs *et al.* (2004b) it is difficult to match agency theoretic concepts directly to data, because the agency models are highly stylized. While the instruments used in this study are not perfect analogues of the theoretical variables, it is believed that they adequately proxy the key concepts of sensitivity, noise and congruency of performance measures. A battery of items using five point fully anchored scales was specifically developed for this study. I derived the items *sensitivity* (EPM_SEN) and *precision* (EPM_PRE) by referring to prior scales developed by Hartmann (1997) and Moers (2001, 2004) and adapting them to the environmental setting (cf. Table C.5 and Table C.6 in Appendix C). The measure of sensitivity included five items like *“If my organizational function well, it is directly reflected in better environmental performance”* and *“The environmental performance measures in my unit provide me with information about environmental performance that I cannot get from performance measures that are not environmental-related”*. The instrument *precision* was measured asking the respondents to provide an opinion on their perceived controllability of environmental performance measures when taking into account six external factors (environmental regulation, economic conditions, customers’ behavior, suppliers’ strategy, competitor’s strategy, production technology). It was assumed that a lower controllability of these factors would be associated with a lower precision signalled by the environmental performance measures. Some of the items were adapted from the instrument *controllability* developed in Nakamura *et al.* (2001).

The instrument relative to the *congruity* of performance measures (EPM_CON) was newly developed for this study: the respondents were asked to provide their judgment about the relationship between the achievement of organizational goals expressed in financial terms and the improvement of environmental performance measures. The items were developed to elicit information about the perceived distortion associated by pursuing environmental-related goals when confronted with a firm’s financial performance (cf. Table C.7 in Appendix C). Sample items for this instrument are: *“An improvement in environmental performance measures leads to an improvement in the long-term value of* *my firm"*; and *"The financial performance of my organizational unit does not depend on its environmental performance"*.

Use of environmental performance measures
Respondents were asked to provide an assessment of the importance of the use of environmental performance measures in their organizational unit. Responses were elicited in an aggregated way with regards to both types of environmental performance measures (non-financial and financial). The instrument was newly developed for this study following prior literature that attempted to measure the differential purposes of management accounting information (Eggleton *et al.*, 2001; Ittner *et al.*, 2003b; Cavalluzzo and Ittner, 2004). The items were differentiated between internal decision-making and control (USE_EPM_INT) versus external accountability (USE_EPM_EXT) as reported in Table C.8 in Appendix C. The internal use of EPMs was measured by ten items distinguishing the use for decision control (items from USE_EPM_DC1 to USE_EPM_DC5) from the use for decision-making (items from USE_EPM_DM1 to USE_EPM_DM5). Five statements were developed to measures USE_EPM_EXT and related to the use of environmental performance as external communication devices towards different audiences. For each of these statements, subjects were asked to indicate their level of agreement on a seven-point not fully anchored Likert scale. The scale differs from all other instruments measured on five-point fully anchored scales, since the objective was to elicit more extreme variation in the responses about the dependent variables in the conceptual model.

Environmental performance
An instrument was developed to elicit an opinion about the effectiveness of environmental strategy as a function of the use of environmental performance measurement systems. In absence of archival data concerning the level of environmental performance, subjective measures have been frequently used to measure outcomes of environmental management practices as reviewed in Section 2.2.1. *Environmental performance* is measured here using an instrument that combines five items related to the reduction of waste in production process, compliance with environmental regulation and improved reputation (cf. Table C.9 in Appendix C). The items were developed referring to prior instruments in Judge and Douglas (1998) and Melnyk *et al* (2003). An additional set of five statements was used to measure *organizational performance*. Improvements in production quality, process costs and marketing reputation were the topics used to elicit responses on the effectiveness of environmental performance measurement system in a manufacturing setting. The selection of the five items was obtained adapting the instrument by Melnyk *et al.* (2003).

4.4.1 Additional variables

Some additional questions included in the questionnaire acted as descriptive variables to generate additional insights about the population of respondents and their organizations.

Other measures served as control variables for the validity of the data or as opinion variables that were supposed to integrate the data analysis. Respondents were asked to indicate their opinion regarding the following three aspects:

Data about respondent's function and demographics

- Demographics;
- Function and task;
- Working experience and tenure;
- Locus of control: using the instrument by Merchant (1981; 1984), one measure asked for the total number of subordinates in the respondent's area of responsibility; another measure assessed the respondent's span of control and asked for the number of subordinates under direct supervision of the respondent;
- Influence on the design of the performance measurement and incentive system: two questions assessed the level of a respondent's involvement in the design of the performance measurement and reward system respectively.

Data about sample characteristics

- Respondents were asked to indicate the company's sector to validate the sample; in addition, industrial codes were derived from the database AMADEUS (refer to endnote 2 in this chapter) to allow a more detailed analysis of the distribution of organizations and potential bias in the respondents;
- Level of analysis: as the sampling selection did not allow the identification the company level at which the respondents were located, it was decided to ask them to indicate whether the organizational unit in which they were employed was respectively at the *corporate*, *business* unit, or at the *operational level*;
- Size of company and size of organizational unit; following Dean and Snell (1991) company's size (SIZE_ORG) was subsequently measured as the natural logarithmic transformation of the number of full-time employees;
- Company structure, being the respondent employed in a subsidiary of a multinational and in a listed company;
- Adoption of Advanced Manufacturing Techniques (AMT) and innovations in Management Accounting: six AMT (Total Quality Management, Just-In-Time, flexible manufacturing, Computer Integrated Manufacturing, Material Requirement Planning and real-time process control systems) and four advanced forms of management accounting techniques (Enterprise Resource Planning, Activity-based costing, Balanced scorecard and Economic Value Added) were identified from prior literature on innovations in management accounting (e.g. Chenhall and Langfield-Smith, 1998b). Respondents were asked to indicate the stage of implementation of each technique, using an anchored scale from zero (no intention to adopt or technique not being considered) to five (technique or innovation fully implemented);

- ISO 9001 certification: the same scale for the adoption of AMT was used to assess the stage of implementation of a certifiable quality management system according to the international standard ISO 9001.

Data about environmental management

- Mandatory reporting: I measured with a dummy variable whether an organization was subject to the Dutch mandatory scheme about environmental reporting;
- Integration of EMIS into accounting systems: this opinion variable relates to a respondent's opinion about the extent to which the EMIS is perceived as integrated within the management accounting system. A slightly similar question was devised in Cavalluzzo and Ittner (2004);
- Ownership of EMIS by controller's function: this opinion variable relates to a respondent's opinion about the extent to which the EMIS is perceived as owned by the controller's function. A slightly similar question was devised in Cavalluzzo and Ittner (2004);
- Estimate of environmental costs and environmental investment compared to 2002: respondents were asked to provide an estimate of the financial resources that their organizational units had spent in 2002 for respectively *environmental costs* (defined by the Dutch Central Bureau of Statistics as yearly operational costs that arise to protect, recover or improve the natural environment) and *environmental investments* (defined by the Dutch Central Bureau of Statistics as investments in assets to protect, recover or improve the natural environment). Similarly to White (1995), the estimate was quantified in percentage terms of environmental costs and environmental investments on, respectively, total operational costs and total investments in 2002;
- ISO 14001 certification: the same scale for the implementation of ISO 9000 quality management system was used to assess the stage of implementation of a certifiable environmental management system according to the international standard ISO 14001.

4.5 Preliminary analysis of the results and item analyses

This section and Appendix E contain descriptive statistics and a preliminary analysis of the data obtained with the questionnaire survey, before performing the statistical analyses of the hypotheses in the next chapter. First, response rate and the demographics of the sample are presented and commented. Furthermore, I analyze the psychometric properties of the instruments. Finally, an analysis of bivariate correlations and means comparison is performed in order to explore the relationships that will be tested further in the next chapter.

4.5.1 Response rate

As reported in Table E.1, of the 285 questionnaires that were distributed, 99 (34.7%) were returned by postal mail using the stamped envelope. Of the 99 questionnaires returned, 18 contained the indication that the respondent a) was unable to fill it out the survey (13 cases); b) changed working place (4 cases), and c) retired (1 case). The final response rate that comprises only usable surveys was therefore 28.4% (*n* = 81). This response rate can be considered satisfactory given the length of the questionnaire, the sensitivity of the environmental-related topic and the salience of the topic for the organizational function occupied by the respondents (cf. Baruch, 1999). The follow-up telephone calls urging completion of the survey allowed explaining the response rate for the entire sample. Table E.1 summarizes the final data about response rate. Overall, it appears that 22.8% of the sample was not eligible, either because the respondent declared that the issues investigated were not pertinent to the company or because the respondent considered her/his knowledge about the topic as inadequate. A rather significant portion of subjects (10.2%) was not able to participate in the survey as it turned out that they had moved to another job in a non-manufacturing sector. Finally, a small fraction of the sample was unable to answer the survey due to a company policy that does not allow employees to fill out questionnaires (1.4%) or because the respondent was not reachable due to temporary leave or service abroad (3.2%). On the basis of this information, it is possible to compute a modified response rate according to the guidelines about survey reporting suggested by the American Association for Public Opinion Research (AAPOR, 2004). By only taking into account the eligible respondents, the corrected response rate rises to 45.5%.[7] This response rate compares favourably with similar studies that employed a survey-based design to collect data. In absolute terms, the number of usable data points is also aligned with previous empirical studies in management accounting that relied upon a survey-based method (cf., for instance, Davila, 2000; Abernethy and Vagnoni, 2004; Chenhall, 2004, 2005).

Table E.2 presents the distribution of the respondents per sector. The majority of respondents were from chemicals companies (22.2%), followed by construction (13.2%) and food products (12.3%).

4.5.2 Sample demographics

Descriptives regarding demographic characteristics of the respondents are summarized in Table E.3. The average age of the respondents in the sample was 38.4 years old. On average, respondents worked with their present employers for 6.4 years and for 3.2 years in their current position. Tenure in the same organizational function amounted on average 7.7 years. About two-thirds of the respondents held a title of Registered Accountants (RA). Most of respondents were employed as controllers (65%), followed by financial directors (28%), general managers (4%) and CFOs (3%). In addition, 79% were members of the management team in their organizational units and held a line function in 47% of the cases. The average number of employees in the respondents' area of responsibility was 76.2 persons. On average, the respondent's span of control - measured by the number of employees under direct supervision - was 7 persons. It is worthwhile noticing that on average the influence of the respondents on the design of the performance measurement system was higher (mean score of 3.66 on a five-point Likert scale) than their influence on the design of the incentive system (means score of 2.47 on a five-point Likert scale). Table E.4 contains descriptive statistics regarding the sample. First, the responses were almost equally distributed among the three organizational levels of analysis with 28 respondents employed at corporate level, 26 at divisional level and 27 at plant level. On average, respondents were employed in companies with 15,655 employees. Specifically, 22% of the companies had between 100 and 500 employees, 9% between 500 and 1,000, 21% between 1.000 and 5,000, 15% between 5,000 and 10,000 and 33% above 10,000 employees.

Respondents indicated that 41% of their companies were subsidiaries of a multinational corporation and that 48% of the companies were publicly-listed. Among the Advanced Manufacturing Technologies implemented in the surveyed companies, the highest scores were obtained for Enterprise Resource Planning (mean 3.49 on a five-point fully anchored scale), followed by Manufacturing Resources Planning (mean 2.96) and Total Quality Management (mean 2.80). Of the 72 respondents that answered the question concerning the implementation of a quality management system in conformity with the international standard ISO 9000, 68% declared to be in conformity with the standard and having obtained a third-party certification.

The data collected with regards to company characteristics related to environmental management are presented in Table E.5. The results show that 41% of the respondents indicated the presence in their organizational unit of a department with a formalized responsibility about environmental issues. The mandatory environmental reporting scheme applied to about 30% of the organizational units. The average estimate of the environmental costs compared to operational costs for 2002 amounted to 3.3%. In addition, the mean of the environmental investments relative to total investments for 2002 amounted to 9.3%. This last figure is not alignment with the data provided annually by the national statistical office of The Netherlands (CBS, 2004): for the period 2000-2004, the average percentage of environmental investments on total investment was stable around 4.2%. The data provided by the respondents might be overstated due to lack of knowledge of exact information, or, more likely, due to common-method bias of respondents that are employed in companies with a higher amount of environmental investment.

About 15% of the respondents strongly agreed or agreed to the statement that the environmental performance measurement systems were generated within the accounting information system. More importantly, only 4% of the respondents agreed about the statement that the ownership of the EMIS was under the controller’s function. These results suggest that on average the environmental performance measurement system tends to be kept separate from traditional, financial-oriented accounting information systems. In addition, controllers seem not to be responsible for the design and functioning of these systems. At the present time, it can be argued that the EMIS remains under the ownership of other functional departments, presumably the ones in charge of environmental management or manufacturing operations. Finally, of the 53 respondents that answered the question concerning the implementation of an environmental management system in conformity with the international standard ISO 14001, 40% declared to have obtained a certification. The lower response rate for this specific item signals that financial and control functions typically have inadequate knowledge about the presence of certified environmental management systems when compared to apparently more popular and more established quality management systems.

4.5.3 Psychometric properties of measurement instruments

This section reports the psychometric properties of the measurement instruments presented in Section 4.4. First, I will assess the *reliability* of the instruments, defined as the consistency or stability of the measurement instrument (Kerlinger and Lee, 2000). Classical theory of measurement error suggests the computation of a reliability index as correlation between a set of scores on a given test and corresponding true scores (Nunnally and Bernstein, 1994). Among the practical methods to obtain the reliability coefficient (which equals the square of the reliability index) suggested in the literature, I will rely upon the internal consistency method of computing the Cronbach's coefficient-α (Cronbach, 1951). Furthermore, exploratory factor analysis (EFA) will be applied to assess the *validity* of the instruments (Kim and Mueller, 1979; Nunnally and Bernstein, 1994; Kerlinger and Lee, 2000; Cooper and Schindler, 2001). I will present the results of the factor analyses following recent suggestions in Fabrigar, Wegener, McCallum and Straham (1999) and Conway and Huffcut (2003) about purposes and reporting of EFA practices in organizational and psychological research. First, concerning the purpose of EPA and the selection of the factor extraction model, principal component analysis (PCA) will be used because the goal is to reduce the number of variables by creating linear combinations that retain as much of the original measures' variance as possible. In other words, the aim of EFA is preliminary evaluating the unidimensionality of new or ad hoc measures rather than evaluate existing measures. Second, with regard to the number of factors criterion, factors are extracted by retaining those having an eigenvalue greater than one. Third, in relation with the rotation techniques used, I will provide arguments to justify orthogonal rotation or oblique rotation depending on the instrument that will be analyzed. Finally, data concerning communalities and percentage of variance accounted for will be presented to complete the analysis. As a general remark over the factor analysis performed in this study, it is relevant to emphasize that in the analysis presented in Chapter 5 I will discuss the complete factor loadings structure of the instruments developed for this survey. The assessment of *convergent* and *discriminant* validity is therefore preliminary presented and discussed in this section, but formally performed in the next chapter using a structural equation modeling approach. Another *caveat* concerns the issue of sample size because it creates some expected problems in interpreting correctly the results of factor analysis. Recent articles discuss the interaction between sample size and communalities as a critical aspect in factor analysis (MacCallum, Widaman, Zhong and Hong, 1999; MacCallum, Widaman, Preacher and Hong, 2001). The limited amount of responses obtained from the survey limits a priori the adequacy of the factor analytic results. It is thus important to acknowledge the exploratory nature of the study.

Results of the reliability and validity analyses are reported in Appendix C. What follows is a brief commentary of the results for each variable investigated.

Environmental strategy

Twenty-one items were included in the questionnaire to capture the construct *environmental strategy* (ENV_STR). Four items (ENV_STR4, ENV_STR7, ENV_STR8, ENV_STR9) were dropped after performing a reliability analysis. After refinement, the scale shows a Cronbach's Alpha beyond acceptable levels ($\alpha = 0.967$). The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy is 0.942 ($p<0.001$) which indicates that factor analysis is appropriate for the seventeen items (refer to Table C.1 in Appendix C). The communalities are in an acceptable range (0.411-0.774). The analysis performed using orthogonal rotation (Varimax) identifies one factor with eigenvalue greater than 1, which accounts for 66.4% of the variance. The results support a unidimensional variable, which combines *principles* (ENV_STR1 to ENV_STR6) and *practices* (ENV_STR10 to ENV_STR21) of environmental management.

Availability of EMIS

For this instrument (EMIS_AVA), all original ten-items included in the questionnaire were retained after performing a reliability analysis. The coefficient Alpha for the ten-item scale was adequate ($\alpha = 0.939$). Subsequent factor analysis revealed one factor with KMO score of 0.842 ($p<0.001$) and 65% of variance explained, lending support for a unidimensional construct (refer to Table C.2 in Appendix C).

Scope and Timeliness of EMIS

For the instruments EMIS_SCO and EMIS_TIM, I obtained a coefficient Alpha respectively of 0.849 and 0.896 (refer to Table C.3 in Appendix C). Two separate factor analysis show that the KMO-score for EMIS_TIM is below acceptable value (0.500), thus signaling concerns about the validity of the two-items construct. In addition, the factor analysis performed with the two instruments simultaneously highlighted the presence of one construct. Even when subject to an orthogonal rotation (Varimax) with two factors imposed, the same patterns emerged with four items loading on one factor. These results display a weak discriminant validity of the instruments. The issue will be further examined in the next chapter when I will report about the survey results using a structural model that embeds a measurement model using Partial Least Squares.

Accuracy of EPMs

Four-items were supposed to capture the variable EMIS_ACC. Reliability analysis was performed, showing a satisfactory Alpha of 0.868 (refer to Table C.4 in Appendix C). Factor analysis revealed one factor with a KMO score of 0.776 (p<0.001), with eigenvalue of 2.9 and 72% of variance explained. This instrument can be considered as reliable and unidimensional.

Sensitivity and Precision of EPMs

The instrument about sensitivity of environmental performance measures was (EPM_SEN) originally composed of five items. Reliability analysis was performed and one item (EPM_SEN5) was dropped. Following trimming of items, the coefficient Alpha obtained was sufficient (α = 0.745) as displayed in Table C.5 and Table C6 in Appendix C. The six-items for the variable precision (EPM_PRE) were all retained and a Cronbach Alpha of 0.826 was obtained. Two separate factor analyses were performed, revealing satisfactory KMO scores. A factor analysis was also run using an oblique rotation (Oblimin) by combining the two sets of items. An oblique rotation was chosen as it was supposed that the two constructs are conceptually not independent. The results show a pattern of factor loadings distributed among the items according to expectations only when two factors are imposed. Moreover, EPM_PRE1 loaded negatively on the sensitivity factor. Taken together, the analysis shows limited support in terms of discriminant validity.

Congruity of EPMs

Of the five-items that initially composed the instrument (EPM_CON), two (EPM_CON1, EPM_CON5) were discarded to increase the reliability of the construct. After refinement of the instrument, the coefficient Alpha for the three-item instrument was a satisfactory 0.748 (refer to Table C.7 in Appendix C). The factor analysis supports the unidimensionality of the three-items, with an eigenvalue of 2.0 and 72% of variance in the underlying variable accounted for. The KMO score is above acceptable value.

Use of EPMs

Three sets of five items each were created to capture respectively the use of environmental performance measures for decision-making (USE_EPM_DM), for decision-control (USE_EPM_DC) and for external accountability (USE_EPM_EXT). The first two instruments are then aggregated to obtain the variable USE_EPM_INT which combines in one construct both decision-making and decision-control purposes. As reported in Table C.8 in Appendix C, reliability analysis for USE_EPM_INT reveals a high coefficient Alpha (α = 0.956). Also the coefficient Alpha for USE_EPM_EXT was satisfactory (α = 0.915). No item was dropped to refine the instruments after reliability analysis. In order to assess the unidimensionality of the two instruments, I performed a factor analysis relying upon a rotation technique (Oblimin) because of the theoretical dependence of the two constructs as suggested in the literature (Sprinkle, 2003). The pattern matrix revealed two factors with the items loading as expected: USE_EPM_DC and USE_EPM_DM loaded on the first factor with eigenvalue of 9.7 and variance explained of 64.4%, while USE_EPM_EXT loaded on the second factor with eigenvalue of 1.5 and variance extracted of 10.2%. As the difference between the first and the second eigenvalue was very high, the two variables can be considered as unidimensional. A further factor analysis was run imposing three factors, with the objective to empirically assess the difference between USE_EPM_DC and USE_EPM_DM. The results provide evidence of the existence of three factors as expected. The argument that the three dimensions of management accounting use are not orthogonal can be supported, however the problem of justifying the number of factors imposed leaves the issue of discriminant validity among the instruments not fully solved. Further insights will be given by examining the cross-loading matrix using the results extracted from the PLS measurement model presented in the next chapter.

Environmental and Organizational performance

A six- and five-items scale was developed respectively to measure environmental (ENV_PER) and organizational (ORG_PER) dimensions of performance. The reliability analysis revealed no need to refine the instruments, as the coefficient Alpha were sufficiently high at $\alpha = 0.914$ for ENV_PER and at $\alpha = 0.862$ for ORG_PER (refer to Table C.9 in Appendix C). In order to assess unidimensionality of the instruments, factor analysis using rotation method (Oblimin) revealed two factors with eigenvalue of 6.8 and 56.5% of variance extracted for ENV_PER. The oblique rotation was performed on the basis of the argument that the two dimensions of performance are likely to be conceptually interdependent. It is noteworthy that a clear pattern of factor loadings was obtained by imposing two factors in the extraction procedure.

4.6 Descriptive statistics

4.6.1 Frequencies

The tables presented in Appendix C also report the frequencies of answers with the highest scores for each variable. Concerning ENV_STR, almost half of the respondents indicate that their companies stated a clear policy urging environmental awareness in every business area. Similarly, about 50% of the answers rate that the concept of “quality management” includes aspects related to environmental management. About 63% note that environmental concerns are primarily driven by requirements to comply with regulation, while the vast majority (81%) believes that their companies have a responsibility to preserve the natural environment. The least developed environmental management aspects appear to be related with the adoption of internal environmental auditing procedures (28% of responses) and the spread of information about environmental performance to the employees (26% of responses).

Among the environmental performance measures that have been developed, respondents indicate that *non-financial* efficiency measures and non-financial impact/risk measures are the most available (48% of responses). In contrast, the least developed indicators appear to be the *financial* management measures (25%), followed by the *non-financial* management measures (30%). Among the other variables regarding EMIS sophistication, it is worth noting that 64% of the respondents believe that their information systems significantly reduce the delay of reporting in case of an environmental accident. Moreover, while 26% of the answers point out that information about environmental performance is difficult to manipulate, one-third of the respondents indicate that an independent party verifies the measurement of environmental performance in their organizational units.

About 54% of the respondents believe that environmental performance measures represent sensitive measures of their performance by providing managers information that is informative in comparison with other performance measures. Among the factors perceived as most uncontrollable in relation with environmental performance, changes in environmental regulation (59%) and changes in manufacturing technology (58%) received the highest responses. Changes in economic conditions, however, are perceived as relevant uncontrollable factors for 23% of the respondents. The evidence concerning the perceived congruency of environmental performance measures suggests that 57% of the respondents agree with the statement that a positive relationship can be established between improvement in environmental performance and long-term value of their companies. At the same time, about half of the respondents note that the occurring of an environmental accident generated or would generate immediate negative financial consequences.

With regards to the uses of environmental performance measures, the responses indicate overall a low use of these metrics for decision-control purposes (USE_EPM_DC). About 22% of respondents indicate that EPMs are actually used to periodically evaluate their organizational unit's performance. Furthermore, only 10% agree with the statement that these performance measures are used to determine personnel's salary increases or promotion. A minority (6%) reports the use of EPMs for the computation of annual bonuses. The scores regarding the use of EPMs for decision-making purposes (USE_EPM_DM) receives on average higher levels of positive responses. In particular, it appears that 26% of the companies employ methods to select and evaluate capital expenditures that include the assessment of environmental aspects. Moreover, about 31% of the respondents believe that EPMs are currently used to assess potential cost-savings in the manufacturing process. Finally, the responses about use of EPMs for external accountability are generally rated with a higher scores compared with the use for internal decision-making and control. As expected, about 40% of the companies note that EPMs are used to supply information to government officials for compliance to environmental regulatory requirements. It is interesting to emphasize that a relatively low amount (35%)

of the respondents indicates that EPMs are used to prepare the corporate environmental report. Only 14% of the respondents report that EPMs are extensively communicated to industrial associations with the purpose of benchmarking environmental performance levels among companies in the same sector.

Finally, some considerations can be drawn when examining the scores about environmental performance (ENV_PER) and organizational performance (ORG_PER). Most respondents agree about the positive effects of environmental management and performance measurement systems on mitigation of environmental risks (53%), compliance with environmental regulation (55%) and prevention of environmental accidents (55%). Much more limited are the perceived effects on organizational performance, where the highest scores were attributed to a general improvement of product quality (49% of responses with an indication of great or very great impact) and reduction of overall production costs (32%). Only a minority of respondents (about 7%) feels that these activities have had a positive effect in terms of improvement of market position in the domestic market.

4.6.2 Descriptive statistics and correlations

Table E.6 provides a summary of the descriptive statistics of the variables included in the conceptual model. The data concerning mean and standard deviation of the variables are computed using equally weighted average of items corrected after reliability and validity analyses. The table also reports statistics of skewness and kurtosis for each variable, with associated test of normality. The data suggest the presence of statistically significant non-normal distributions of responses for all the variables included in the conceptual model.

The correlation matrix displayed in Table E.7 in Appendix E reports both Spearman and Pearson correlations among the variables used in this study. Most associations are significant at the 1% level (two-tailed). As expected, ENV_STR is highly positively correlated with attributes of EMIS. Likewise, ENV_STR positively correlates with the perceived measures concerning sensitivity and congruity. Contrary to expectations, the relationship between environmental strategy and precision of environmental performance measures is significantly negative. The data thus suggest that in presence of a lower level of perceived precision (or, vice versa, a higher level of perceived uncontrollable factors that tend to affect environmental performance), companies are more likely to formulate and implement a proactive environmental strategy. Another tentative explanation would relate to the inability of the measurement instrument EPM_PRE to appropriately capture the construct of performance measures' precision. The instrument might in fact denote a measure of *environmental uncertainty* applied to the empirical setting of environmental management. Further considerations about this measure will follow in the next chapter. It can be argued that the inappropriate instrument specification might be a correct explanation of the unexpected results, given the negative sign in the correlation table with the variable EPM_PRE with all other remaining variables. Finally, it is worth noting that the correlation between USE_EPM_DM and USE_EPM_DC is high (r = 0.84) and statistically significant. Overall, the data support therefore a positive relationship between the extent to which specific performance measures are used for decision-control purposes and the use of the same measures for decision-making. More in-depth analysis concerning the *consistency* of use will be explored in the hypothesis test section in the next chapter.

The amount of statistically significant correlations that emerges from Table E.7 can be explained by the presence in the model investigated of endogenous variables that tend to tap on similar constructs. On this issue, I will devote more space in the analysis attached to the Partial Least Squares model whose results are presented in the next chapter. It can be anticipated though that the high correlations among variables is likely to raise a problem related to a lack of discriminant validity among constructs in the measurement model. At the same time, multicollinearity might represent a serious limitation to corroborate the hypothesized relationships using traditional regression analysis techniques.

I performed an analysis of variance to test for significant differences between companies classified as *reactive* and *proactive* companies. ANOVA's were conducted by using a dichotomous variable obtained after splitting the variable ENV_STR at the mean value. As a result, 40 companies could be classified as *reactive* and 37 as *proactive* in terms of their environmental strategy. The results of ANOVA are reported in Table E.8 in Appendix E and show significant differences between the two groups for all the variables specified in the conceptual framework, except for the variable SIZE.

4.6.3 Additional univariate analyses

Supplemental statistical tests were performed to explore the relationships among variables included in the model and additional variables described in Section 4.4.1. Correlations among relevant variables are highlighted. For some variables, I performed t-tests in order to assess significant differences among responses. I summarize the results of these tests focusing on the following group of variables: 1) Respondent's function and demographics; 2) Sample characteristics; and 3) Environmental management aspects.

Univariate statistics regarding respondent's function

No significant difference was found between respondents holding a Registered Controller title (mean score of 3.80) and Registered Accountant title (mean score of 3.50) on the influence on the design of performance measurement systems (ANOVA F = 0.5, p = 0.602). Similarly, no significant difference was found between respondents holding a RC title and RA title (same mean score of 2.40) on the influence on the design of incentive systems. This suggests that a respondent's title had no influence on the design of performance measures and incentive systems. Despite the majority of respondents was classified as having a RA title (65.4%), no bias is caused in terms of getting informed responses about the design of performance measurement and incentive systems. The lack of significant differences between RA's and RC's holds also across the three levels of analysis, as well for all the variables included in the conceptual model (data not reported here). Similarly, no significant difference in means concerning the design of performance measures and all the variables object of study in the conceptual framework was detected between answers provided by respondents in a controllership function in comparison with other function. In sum, it can be argued that the function occupied by the respondent did not introduce any bias in terms of specific knowledge of the respondents inherent to the topics object of the survey.

Univariate statistics regarding sample characteristics

The correlation matrix extended to additional variables concerning sample characteristics (not reported here) reports a statistically positive correlation (significant at the 1% level, two-tailed) among companies that adopted Total Quality Management and ENV_STR (r = 0.36). It can be suggested that quality management systems tend to be associated with more proactive environmental management systems, consistently with the arguments provided in Section 2.2.1 and Section 3.2.1 about the analogies in managerial philosophy and practices that characterize the two systems. Similarly, I found a positive correlation between ENV_STR and organizational units certified ISO 9000 (r = 0.28, significant at the 5% level). Among the correlations between ENV_STR and the other advanced manufacturing technologies presented in Section 4.4.1, positive correlations (statistically significant at the 1% level) are found with regards to Computer Integrated Manufacturing (r = 0.43), Real-time process control systems (r = 0.58) and the Balanced Scorecard (r = 0.31).

Univariate statistics regarding environmental management aspects

A positive and significant correlation is found between ENV_STR and the estimate of environmental costs relative to total costs (r = 0.30, significant at the 5% level). Even stronger is the correlation between ENV_STR and the estimate provided with regards to environmental investments relative to total investments (r = 0.49, significant at the 1% level). The data provide evidence that organizations that are more active in the implementation of environmental management practices tend to spend/invest more financial resources for environmental-related purposes. Concerning structural arrangements of environmental management, ENV_STR positively correlates with the presence of an environmental department in the organizational unit (r = 0.64, significant at the 1% level). The data confirm that companies that are more proactive with their environmental strategies tend to allocate clearer responsibilities about the environmental practices of their operations to specialized departments.

An analysis of variance was performed to assess whether there are significant differences between *reactive* and *proactive* companies in terms of the integration of EMIS into the traditional accounting system. The results provide a significant difference (F = 29.7, p = 0.000), which indicates that organizations that demonstrate a stronger commitment towards the environment are more likely to have invested in their management information system to provide suitable information on environmental performance. In addition, an ANOVA referring to the ownership of the EMIS by the controllership function yields a significant difference (F = 5.8, p = 0.018). This result emphasizes the more central role played by the controllership functions in the design and use of environmental performance measures when companies are characterized by more proactive environmental strategies.

4.7 Non-response analysis: early and late respondents

The likelihood of non-response bias was assessed using late responses as a proxy for non-responses. For each questionnaire the date of both distribution and return was recorded. The median response time was then used to split the respondents into *early* and *late* respondents. The number of respondents with a median response time was 2, with 39 early respondents and 40 late respondents. Table E.9 in Appendix E contains mean and standard deviation scores for all variables tested in the model distinguishing early and late group of response.

Also the results of an independent *t*-test for potential response bias are presented. A comparison of the means of the two groups indicates the absence of significant differences between early and late respondents. Similar results are obtained using the nonparametric *Mann-Whitney* U-test, which assesses whether two independent samples are from the same population (results are displayed in Table E.10). To conclude, the results show no evidence of systematic bias from non-response.

4.8 Summary

In this chapter I presented the survey research method and the preliminary statistical analysis of the data collected. The survey was designed within a broader research project under the sponsorship of the Dutch Institute of Chartered Controllers. I explicitly addressed a sample of 285 financial managers and controllers employed in Dutch manufacturing sectors to elicit information about the variables and their linkages according to the theoretical model developed in Chapter 3. The entire process of the questionnaire design followed the recommendations of the *Total Design Method* by Dillman (2000) to increase the response rate. Data regarding the environmental strategy, informational attributes of environmental management information systems and use of environmental performance measures was eventually collected from 81 respondents. The response rate is not particularly high, but it compares satisfactorily with similar exploratory studies. The presence of a significant portion of subjects that were not acknowledgeable about the topic investigated negatively affected survey participation. The questionnaire contained additional sections about organizational characteristics and controllership function that were included to complete the analysis. A preliminary scrutiny of the data reveals variation in the diffusion of environmental performance measurement systems. By and large, univariate statistics seems to confirm the predicted relationships in conformity with the hypotheses. Some concerns were raised in particular with the instrument intended to measure the *precision* of environmental performance measures. In this respect, it must be emphasized that the selection of the measurement instruments was executed after a careful review of prior survey studies in management accounting and environmental management. However, most of the instruments were newly developed or adapted for this study, increasing therefore the problems inherent to the psychometric properties of the variables. Additional analysis will be performed in the next chapter using an appropriate regression technique that combines measurement and structural modeling together.

Endnotes Chapter 4

[1] Briefly after the data was collected, a preliminary data analysis was performed and an article was published on the same professional journal presenting the preliminary results (Bouwens, Hartmann, Maas, Perego and van Rinsum, 2003b).

[2] Guided by social exchange theory, TDM emphasizes how the survey design elements fit together more than the effectiveness of any individual technique (Dillman, 2000). Social exchange theory posits that questionnaire recipients are most likely to respond if they expect that the perceived benefits of responding will outweigh the perceived costs of responding. According to the theoretical frame of TDM, the questionnaire development and the survey implementation process is subject to three considerations: 1) reducing the perceived cost, such as making the questionnaire short and easy to complete; 2) increasing perceived rewards, such as making the questionnaire itself interesting to fill out; and 3) increasing trust, such as using official stationery and sponsorship.

[3] The database is called *AMADEUS* and is developed by the company Bureau van Dijk Electronic Publishing. It contains financial data about, among others, companies operating in The Netherlands. For further information, refer to: htpp://www.bvd.nl/amadeus.

[4] At country level, the majority of Dutch RAs and RCs are employed in the financial sector.

[5] The specific terms defined were the following: *environment*, *environmental aspects, environmental management*, *environmental performance*, *environmental performance measures*.

[6] In Banjeree (2002), a further distinction is made about a firm's *internal* or *external* environmental orientation. *Internal environmental orientation* reflects a company's internal values, standards of ethical behavior and commitment to environmental protection. *External environmental orientation* refers to the aspects of a firm's environmental orientation that affect its relationship with external constituencies, such as financial shareholders or community stakeholders.

[7] Obtained as follows: 81/(81+97).

CHAPTER 5
SURVEY RESULTS

5.1 Introduction

In this chapter I report the results of the tests of hypotheses developed in Chapter 3 of this dissertation. The chapter is structured in two parts, parallel to Chapter 3. In the first part of the chapter, I will present the data analysis concerning the model about determinants of the use of EPMs. The predictions about the relationships among environmental strategy, environmental performance measurement attributes and use of environmental performance measures were conceptually modeled using a *selection*-fit approach. A structural equation modeling technique is employed to test the set of paths posited in the model. Section 5.2.1 provides a justification of the selection of Partial Least Squares as data analysis technique and a brief illustration of its main statistical features. Section 5.2.2 contains the results concerning reliability and validity analysis (*measurement* model). Section 5.2.3 presents the formal hypothesis testing (*structural* model). Additional statistical analyses are performed in Section 5.3 in order to enable a richer understanding of the data. A discussion of findings is presented in Section 5.4. Further, Section 5.5 reports the results for the hypothesis regarding the consistency of use of environmental performance measures. In the second part of the chapter, the *mediation*-fit model presented in Chapter 3 to address performance effects of environmental performance measurement systems is formally tested. It was posited that environmental strategy positively affects the level of a company's environmental performance through the intervening role of the use of environmental performance measures for internal control. Section 5.6 reports the formal tests of the mediation model. Limitations of the survey design and model specification are discussed in Section 5.7. The section concludes by providing the conceptual and empirical arguments for the qualitative case study that will be presented in Chapter 6.

5.2 Determinants of environmental performance measurement systems design and use

5.2.1 Data analysis technique: Partial Least Squares

The hypothesized relationships for this study were tested using a structural equation modeling technique called Partial Least Squares (PLS). In this study I used PLS Graph (version 3.0) developed by Chin (2001). PLS regression is a statistical technique that generalizes and combines features from principal component analysis and multiple regression analysis (cf. Abdi, 2003). PLS originated in the late Sixties by Herman Wold as an econometric technique to deal with multiple regression problems where the number of observations is limited, missing data are numerous and the correlations between predictors are high (Chin, 1997; Chin and Newsted, 1999). These features of PLS regression have been demonstrated both with real data and in simulations (Garthwaite, 1994). Over the years, PLS has been used in scientific fields where the problem of linking a great number of correlated variables through a limited number of observations is particularly acute, such as in chemistry. More recently, its use has diffused in a growing number of social sciences, particularly in research areas like information management (e.g. Agarwal and Karahanna, 2000; Venkatesh, 2000; Croteau and Bergeron, 2001; Chin, Marcolin and Newsted, 2003; Yi and Davis, 2003) and strategic management (e.g. Tsang, 2002; Brown and Chin, 2004; Gray and Meister, 2004). PLS applications in the field of management accounting can be found in Vandenbosch (1999), Anderson, Hesford and Young (2002) and Chenhall (2004; 2005).

In this study, PLS was employed to test the hypotheses formulated in Chapter 3 for several reasons. Conceptually, PLS is an iterative combination of principal component analysis relating measures to constructs, and path analysis permitting the construction of a system of constructs (Barclay, Higgins and Thompson, 1995). The objective of PLS analysis is oriented toward predictive applications and the explanation of variance as in regression analysis, in which R^2 and the significance of relationships among constructs indicate how well a model performs (Chatelin, Esposito and Tenenhaus, 2002). Specifically, PLS generates estimates of standardized regression coefficients (i.e. path coefficients), which can then be used to assess the relationships between latent variables. This technique thus enables the analysis of complex nomological networks of constructs like the one modeled in the present study. The same analysis would be not suitable in the context of traditional statistical techniques. In fact, PLS does not make assumptions about a) data distributions to estimate model parameters, b) observation independence, or c) variable metrics (Fornell and Larcker, 1981; Chin and Newsted, 1999). Because of its less restrictive assumptions, PLS is preferred over alternative structural modeling software programs (like LISREL, EQS or AMOS), which typically require multivariate normality and larger sample size. In addition, it is worth noting that the standard error of estimates in PLS may be more than 100 times smaller than those of ordinary least squares estimates

(Wilcox, 1998). To sum up, PLS is better suited in the early stage of theory development for the analysis of complex structural models that need to be tested in presence of small samples. Moreover, PLS compares favorably to alternative structural modeling techniques when non-normality is detected from the data, as it is the case for this study.

Although PLS estimates both factor loadings and structural paths simultaneously, I followed the procedure advocated by Chin (1998) and Hulland (1999) in evaluating PLS models. The proposed model about determinants of use of environmental performance measurement was analyzed and interpreted in two stages. The first stage consists of the assessment and reliability of the *measurement* model representing the relationships between constructs and their instrumental measures. The second stage allows for the testing of the *structural* model that represents the relationships among constructs. The simultaneous analysis of measurement and structural components facilitates measurement reliability and validity assessment within the context of the theoretical model being tested. This approach ensures that the constructs' measures are valid and reliable before attempting to draw conclusions regarding the modeled relationships among the constructs themselves. Thus, PLS acknowledges that the psychometric properties of the measures derive their meaning from the nomological network of relationships in which the same measures are employed.

Another important aspect in structural equation modeling concerns the definition and measurement of latent variables (cf. Bollen and Lennox, 1991; Pedhazur and Schmelkin, 1991; Nunnally and Bernstein, 1994). In this study the nature of the relationships between latent constructs and manifest variables is *reflective*: indicators are supposed to reflect the unobserved, underlying construct, with the construct giving rise to (or 'causing') the observed measures. As such it is appropriate to identify reliability and validity properties of the measures. An alternative approach would instead define *formative* indicators, in which a defined construct is completely determined, or 'formed', by a linear combination of its indicators (cf. Chin, 1998; Diamantopoulos and Winklhofer, 2001; Burke Jarvis *et al.*, 2003). Finally, Chin's (1998) rule of thumb suggests that the sample size for a PLS study should be equal to the larger of the following: a) 10 times the scale with the largest number of *formative* indicators (condition not applicable to this study), *or* b) 10 times the largest number of structural paths directed at a particular construct in the structural model. In this study the dependent variable USE_EPM_INT is modelled as an endogenous variables explained by 8 variables. Hence, the second condition is merely satisfied given a sample size of 81 usable data points from the survey.

5.2.2 Measurement model

Following recent empirical studies that used partial least squares for their data analysis, the strength of the measurement model in PLS can be assessed through tests of *item reliability*, *convergent* and *discriminant* validity (cf. Barclay *et al.*, 1995; Hulland, 1999; Agarwal and Karahanna, 2000; Sarkar, Echambadi, Cavusgil and Aulakh, 2001; Tsang, 2002; Brown and Chin, 2004; Gray and Meister, 2004; Johnston, McCutcheon, Stuart and Kerwood, 2004). PLS outcomes provide additional evidence on the measurement aspects that were outlined in the reliability and validity analyses presented in the previous chapter.

For each variable conceptualized in the nomological network, I assessed individual *item reliability* by examining the item-to-construct loadings. In order for the shared variance between each item and its associated construct to exceed the error variance, the standardized loadings should be greater than the recommended threshold of 0.707 as indicated by Carmines and Zeller (1979). This threshold translates in a shared variance of 50% or greater between the item and the construct. However, during early stages of scale development even loadings of 0.5 or 0.6 may still be acceptable for an item, if other indicators within the same block of measures show higher loadings (Chin, 1998). As reported in Table 5.1, the factor loadings of items associated with each construct were high, equaling or exceeding a value of 0.622 (corresponding to the loading of the item ENV_STR5). Overall, these statistics indicate that all the items selected after item trimming in Chapter 4 demonstrate satisfactory individual-item reliabilities.

Convergence validity refers to the degree to which construct operationalization is similar to (converges on) other operationalizations that it theoretically should be similar to. To assess a variable's convergent validity, the composite reliability scores and Cronbach's Alpha scores both provide a measure of the internal consistency within a given construct's set of items (their values are reported in Table 5.1). Unlike the more traditional Cronbach's Alpha, the internal composite reliability (ICR) score developed by Fornell and Larcker (1981) does not assume that all indicators are equally weighted.[1]

Cronbach's Alpha tends to be a lower bound estimate of reliability, whereas the composite reliability score is a closer approximation under the assumption that the parameter estimates are accurate (Chin, 1998:320). The threshold values for ICR and Cronbach's Alpha are not absolute ones. Nunnally (1978) recommends the cut-off of 0.7 as an acceptable benchmark for 'modest' reliability in the early stages of research. Both the internal consistency score and Cronbach's Alpha of each construct were equal or larger than 0.7, thus indicating that the reliabilities of all the constructs in the model were established satisfactorily (Hulland, 1999).

Finally, to complete the psychometric assessment of the measurement model, I examine the *discriminant* validity of the variables. The issue of discriminant validity addresses the potential problem of developing measures for one construct that might overlap the conceptual territory of another construct. Fornell and Larcker (1981) suggest the use of Average Variance Extracted or AVE (i.e. the average variance shared between a construct and its measures).[2] The output obtained in PLS Graph indicates that the average variances extracted in all the constructs were at least or greater than 0.50. The lowest AVE referred to the variable EPM_PRE at 0.533; some concern was already emphasized in the previous chapter in terms of content validity for this variable instrument. In general, though, the AVE scores are indicative of satisfactory discriminant validity.

Table 5.1 – Reliability analysis of the instruments

Variables	*Internal Composite Reliability*	*Cronbach's Alpha*	*Average Variance Extracted*	*Items*	*Factor loadings*	*Weights of measures*
Environmental strategy	0.969	0.967	0.648	ENV_STR1	0.809	0.072
				ENV_STR2	0.867	0.077
				ENV_STR3	0.810	0.073
				ENV_STR5	0.622	0.046
				ENV_STR6	0.756	0.065
				ENV_STR10	0.815	0.075
				ENV_STR11	0.871	0.081
				ENV_STR12	0.863	0.081
				ENV_STR13	0.715	0.063
				ENV_STR14	0.858	0.084
				ENV_STR15	0.856	0.077
				ENV_STR16	0.820	0.076
				ENV_STR17	0.809	0.078
				ENV_STR18	0.800	0.079
				ENV_STR19	0.777	0.076
				ENV_STR20	0.787	0.066
				ENV_STR21	0.814	0.073
Availability EMIS	0.948	0.939	0.647	EMIS_AVA1	0.818	0.120
				EMIS_AVA2	0.889	0.140
				EMIS_AVA3	0.755	0.129
				EMIS_AVA4	0.863	0.141
				EMIS_AVA5	0.838	0.144
				EMIS_AVA6	0.759	0.102
				EMIS_AVA7	0.801	0.118
				EMIS_AVA8	0.722	0.112
				EMIS_AVA9	0.791	0.112
				EMIS_AVA10	0.796	0.114
Scope EMIS	0.908	0.849	0.767	EMIS_SCO1	0.832	0.333
				EMIS_SCO2	0.916	0.418
				EMIS_SCO3	0.877	0.397

Table 5.1 (continued)

Variables	*Internal Composite Reliability*	*Cronbach's Alpha*	*Average Variance Extracted*	*Items*	*Factor loadings*	*Weights of measures*
Timeliness	0.951	0.896	0.906	EMIS_TIM1	0.956	0.548
EMIS				EMIS_TIM1	0.948	0.503
Accuracy	0.911	0.868	0.720	EMIS_ACC1	0.913	0.365
EMIS				EMIS_ACC2	0.933	0.321
				EMIS_ACC3	0.725	0.192
				EMIS_ACC4	0.806	0.283
Sensitivity	0.842	0.745	0.574	EPM_SEN1	0.777	0.364
EPMs				EPM_SEN2	0.755	0.269
				EPM_SEN3	0.831	0.395
				EPM_SEN4	0.656	0.285
Precision	0.872	0.826	0.533	EPM_PRE1	0.673	0.275
EPMs				EPM_PRE2	0.686	0.177
				EPM_PRE3	0.742	0.178
				EPM_PRE4	0.781	0.243
				EPM_PRE5	0.669	0.175
				EPM_PRE6	0.818	0.312
Congruity	0.848	0.748	0.652	EPM_CON2	0.875	0.535
EPMs				EPM_CON3	0.684	0.221
				EPM_CON4	0.851	0.447
Use of EPMs	0.963	0.956	0.724	USE_EPM_DC1	0.846	0.133
Internal				USE_EPM_DC2	0.829	0.097
control				USE_EPM_DC3	0.898	0.116
				USE_EPM_DC4	0.858	0.101
				USE_EPM_DC5	0.869	0.123
				USE_EPM_DM1	0.876	0.124
				USE_EPM_DM2	0.850	0.122
				USE_EPM_DM3	0.851	0.112
				USE_EPM_DM4	0.835	0.126
				USE_EPM_DM5	0.792	0.114

Table 5.1 (continued)

Variables	*Internal Composite Reliability*	*Cronbach's Alpha*	*Average Variance Extracted*	*Items*	*Factor loadings*	*Weights of measures*
Use of EPMs External accountability	0.939	0.915	0.754	USE_EPM_EXT1	0.802	0.182
				USE_EPM_EXT2	0.903	0.252
				USE_EPM_EXT3	0.874	0.221
				USE_EPM_EXT4	0.875	0.239
				USE_EPM_EXT5	0.884	0.253

Notes: sample size n = 81. The Cronbach Alpha's were obtained using SPSS 11.0 and were reported in Chapter 4 (refer to Appendix C).

A second variant to evaluate discriminant validity consists of examining the loadings and the cross-loadings of each indicator on the latent constructs (cf. Fornell and Larcker, 1981; Chin, 1998; Agarwal and Karahanna, 2000). Cross-loadings are defined as the correlation between standardized item scores and latent variables. PLS Graph does not provide cross-loadings on constructs other than the respective latent variables. Therefore, I calculated the cross-loadings following the instructions indicated in published articles, particularly referring to the procedure explained in Smith, Keil and Depledge (2001) and Yi and Davis (2003). Specifically, 1) I estimated a standardized version of each indicator in the PLS output (so-called *rescaled data matrix* in PLS Graph); 2) I obtained the factor scores for each respondent from the so-called *eta* or latent variable matrix in PLS Graph; 3) I correlated all standardized indicator values against all factor scores using Pearson correlation in SPSS. For an indicator's intended construct, this correlation represents its 'loading' as reported in the PLS Graph output. The correlations computed in SPSS indeed exactly corresponded to those calculated in PLS Graph. For other constructs, this correlation coefficient represents the 'cross-loading' value shown in Table 5.2.

As can be seen by reading across the rows and columns of Table 5.2, most of the indicators show a higher loading with their construct than with any other construct. However, a closer scrutiny of the matrix reveals that factor loadings for environmental strategy score high also for other two constructs (i.e. EMIS_AVA, USE_INT), therefore signalling a lack of distinctiveness between these two variables. This finding was anticipated after having analysed the correlation matrix presented in the previous Chapter[3], where I already emphasized that the presence of high and significant correlations among constructs was likely to raise concern about discriminant validity for these variables. As a final test of discriminant validity, I considered whether the square roots of AVEs of the latent constructs were greater than the correlations among the latent constructs. When this occurs, more variance is shared between the latent construct and its battery of items than with another construct (Chin, 1998). As can be seen by reading across the matrix displayed in Table 5.3, most of the square roots of AVEs (presented on the diagonal values) are indeed higher than the bivariate Pearson correlation coefficients. Problems concerning discriminant validity emerge with respect to ENV_STR and EMIS_AVA, since the AVEs scores for these two variables appear to be lower than at least one other correlation value in the same row or column. These results reinforce the concern about discriminant validity with respect to three constructs: environmental strategy, availability of environmental performance measures and use of environmental performance measures for internal control. On the other hand, the overall model provides reasonable evidence of discriminant validity in that the variance shared between any two constructs was less than the average variance extracted by the constructs. Moreover, eight out of ten constructs exhibited higher loadings on intended instruments than on other constructs (Hulland, 1999).

Table 5.2 – Factor loadings and cross loadings

Variables	***Items***	**1.**	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**	**10.**
1. Environmental	ENV_STR1	**0.809**	0.674	0.634	0.655	0.552	0.435	-0.442	0.435	0.638	0.718
strategy	ENV_STR2	**0.867**	0.738	0.625	0.720	0.669	0.465	-0.364	0.465	0.738	0.688
	ENV_STR3	**0.810**	0.708	0.610	0.698	0.641	0.365	-0.397	0.357	0.642	0.733
	ENV_STR5	**0.622**	0.445	0.234	0.406	0.366	0.268	-0.289	0.258	0.496	0.492
	ENV_STR6	**0.756**	0.570	0.514	0.563	0.494	0.451	-0.489	0.411	0.611	0.579
	ENV_STR10	**0.815**	0.724	0.706	0.723	0.629	0.474	-0.461	0.521	0.683	0.607
	ENV_STR11	**0.871**	0.763	0.683	0.760	0.724	0.526	-0.513	0.513	0.698	0.703
	ENV_STR12	**0.863**	0.807	0.685	0.770	0.751	0.534	-0.468	0.518	0.664	0.716
	ENV_STR13	**0.715**	0.559	0.602	0.561	0.605	0.429	-0.404	0.373	0.539	0.507
	ENV_STR14	**0.858**	0.755	0.711	0.832	0.782	0.577	-0.517	0.590	0.669	0.672
	ENV_STR15	**0.856**	0.704	0.677	0.713	0.687	0.528	-0.573	0.541	0.594	0.670
	ENV_STR16	**0.820**	0.710	0.663	0.653	0.755	0.511	-0.487	0.430	0.636	0.704
	ENV_STR17	**0.809**	0.748	0.654	0.709	0.700	0.512	-0519	0.554	0.684	0.659
	ENV_STR18	**0.800**	0.746	0.638	0.673	0.701	0.473	-0.619	0.536	0.697	0.687
	ENV_STR19	**0.777**	0.720	0.731	0.652	0.721	0.466	-0.502	0.431	0.582	0.728
	ENV_STR20	**0.787**	0.649	0.540	0.608	0.597	0.517	-0.337	0.488	0.587	0.557
	ENV_STR21	**0.814**	0.772	0.587	0.672	0.640	0.488	-0.389	0.479	0.655	0.650
2. Availability	EMIS_AVA1	0.673	**0.818**	0.593	0.702	0.672	0.487	-0.255	0.487	0.649	0.563
EMIS	EMIS_AVA2	0.766	**0.889**	0.667	0.723	0.684	0.488	-0.376	0.488	0.727	0.741
	EMIS_AVA3	0.692	**0.755**	0.535	0.625	0.570	0.575	-0.323	0.443	0.712	0.632
	EMIS_AVA4	0.826	**0.863**	0.701	0.746	0.703	0.445	-0.393	0.485	0.676	0.731
	EMIS_AVA5	0.854	**0.838**	0.655	0.751	0.743	0.496	-0.441	0.462	0.710	0.723
	EMIS_AVA6	0.486	**0.759**	0.494	0.549	0.524	0.402	-0.284	0.394	0.622	0.511
	EMIS_AVA7	0.644	**0.801**	0.567	0.582	0.610	0.320	-0.328	0.395	0.586	0.642
	EMIS_AVA8	0.580	**0.722**	0.515	0.590	0.566	0.543	-0.332	0.520	0.655	0.538
	EMIS_AVA9	0.664	**0.791**	0.534	0.610	0.625	0.357	-0.286	0.472	0.652	0.583
	EMIS_AVA10	0.609	**0.796**	0.595	0.627	0.664	0.343	-0.276	0.434	0.591	0.596
3. Scope	EMIS_SCO1	0.539	0.576	**0.832**	0.674	0.666	0.372	-0.228	0.274	0.468	0.461
EMIS	EMIS_SCO2	0.738	0.702	**0.916**	0.766	0.682	0.467	-0.423	0.451	0.616	0.548
	EMIS_SCO3	0.679	0.638	**0.877**	0.733	0.701	0.453	-0.392	0.452	0.538	0.604
4. Timeliness	EMIS_TIM1	0.831	0.802	0.800	**0.956**	0.819	0.581	-0.424	0.529	0.666	0.656
EMIS	EMIS_TIM2	0.734	0.746	0.777	**0.948**	0.767	0.490	-0.393	0.511	0.669	0.572

Table 5.2 (continued)

5. Accuracy	EMIS_ACC1	0.789	0.807	0.771	0.816	**0.913**	0.529	-0.354	0.433	0.711	0.710
EMIS	EMIS_ACC2	0.698	0.715	0.710	0.814	**0.933**	0.525	-0.379	0.482	0.613	0.620
	EMIS_ACC3	0.483	0.478	0.460	0.522	**0.725**	0.327	-0.223	0.187	0.310	0.359
	EMIS_ACC4	0.666	0.632	0.639	0.619	**0.806**	0.358	-0.248	0.393	0.455	0.573
6. Sensitivity	EPM_SEN1	0.468	0.394	0.342	0.426	0.402	**0.777**	-0.459	0.559	0.500	0.468
EPMs	EPM_SEN2	0.344	0.308	0.217	0.282	0.300	**0.755**	-0.237	0.514	0.376	0.313
	EPM_SEN3	0.504	0.532	0.550	0.526	0.443	**0.831**	-0.442	0.593	0.542	0.428
	EPM_SEN4	0.422	0.481	0.336	0.443	0.436	**0.656**	-0.239	0.284	0.330	0.388
7. Precision	EPM_PRE1	-0.469	-0.395	-0.446	-0.332	-0.409	-0.413	**0.673**	-0.312	-0.420	-0.505
EPMs	EPM_PRE2	-0.294	-0.191	-0.200	-0.261	-0.206	-0.261	**0.686**	-0.355	-0.267	-0.246
	EPM_PRE3	-0.282	-0.207	-0.149	-0.188	-0.110	-0.338	**0.742**	-0.476	-0.285	-0.337
	EPM_PRE4	-0.411	-0.271	-0.269	-0.371	-0.258	-0.368	**0.781**	-0.526	-0.388	-0.355
	EPM_PRE5	-0.285	-0.211	-0.127	-0.247	-0.176	-0.216	**0.669**	-0.417	-0.259	-0.206
	EPM_PRE6	-0.511	-0.425	-0.431	-0.406	-0.334	-0.396	**0.818**	-0.495	-0.502	-0.469
8. Congruity	EPM_CON2	0.552	0.546	0.486	0.544	0.469	0.630	-0.528	**0.875**	0.569	0.440
EPMs	EPM_CON3	0.231	0.183	0.195	0.262	0.181	0.313	-0.401	**0.684**	0.234	0.179
	EPM_CON4	0.519	0.530	0.343	0.442	0.378	0.559	-0.483	**0.851**	0.417	0.417
9. Use of EPMs	USE_EPM_DC1	0.788	0.779	0.580	0.671	0.625	0.572	-0.498	0.488	**0.846**	0.697
Internal	USE_EPM_DC2	0.540	0.558	0.386	0.433	0.404	0.361	-0.328	0.392	**0.829**	0.507
control	USE_EPM_DC3	0.641	0.655	0.474	0.554	0.492	0.503	-0.395	0.463	**0.898**	0.571
	USE_EPM_DC4	0.636	0.624	0.428	0.482	0.437	0.481	-0.310	0.429	**0.858**	0.581
	USE_EPM_DC5	0.724	0.714	0.562	0.649	0.564	0.578	-0.440	0.499	**0.869**	0.652
	USE_EPM_DM1	0.688	0.732	0.564	0.620	0.532	0.532	-0.442	0.428	**0.876**	0.666
	USE_EPM_DM2	0.646	0.713	0.550	0.594	0.549	0.482	-0.551	0.495	**0.850**	0.655
	USE_EPM_DM3	0.599	0.660	0.535	0.591	0.492	0.466	-0.541	0.484	**0.851**	0.563
	USE_EPM_DM4	0.727	0.778	0.615	0.705	0.698	0.534	-0.385	0.477	**0.835**	0.686
	USE_EPM_DM5	0.594	0.712	0.552	0.610	0.635	0.472	-0.403	0.445	**0.792**	0.583
10. Use of	USE_EPM_EXT1	0.549	0.533	0.402	0.463	0.455	0.462	-0.313	0.360	0.542	**0.802**
EPMs	USE_EPM_EXT2	0.772	0.708	0.556	0.584	0.611	0.401	-0.395	0.325	0.610	**0.903**
External	USE_EPM_EXT3	0.622	0.686	0.554	0.537	0.647	0.420	-0.312	0.297	0.577	**0.874**
accountability	USE_EPM_EXT4	0.737	0.698	0.532	0.593	0.608	0.524	-0.571	0.471	0.717	**0.875**
	USE_EPM_EXT5	0.763	0.755	0.611	0.612	0.648	0.515	-0.564	0.538	0.703	**0.884**

Notes: sample size *n* = 81. To ensure discriminant validity items should load high (>0.707) on their respective constructs (in bold) and no item should load higher on constructs other than the one it was intended to measure.

Table 5.3 – Correlations matrix among variables obtained from PLS Graph

Variables	**1.**	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**	**10.**
1. ENV_STR	**0.805**									
2. EMIS_AVA	0.857	**0.804**								
3. EMIS_SCO	0.753	0.733	**0.867**							
4. EMIS_TIM	0.825	0.814	0.829	**0.952**						
5. EMIS_ACC	0.798	0.795	0.778	0.834	**0.849**					
6. EPM_SEN	0.584	0.573	0.495	0.564	0.526	**0.758**				
7. EPM_PRE	-0.540	-0.414	-0.406	-0.431	-0.366	-0.475	**0.730**			
8. EPM_CON	0.580	0.570	0.456	0.547	0.460	0.526	-0.588	**0.807**		
9. USE_EPM_INT	0.781	0.820	0.622	0.701	0.644	0.591	-0.510	0.543	**0.851**	
10. USE_EPM_EXT	0.805	0.785	0.618	0.647	0.698	0.534	-0.506	0.462	0.730	**0.868**

Notes: Bold-faced elements on the diagonal represent the square root of the Average Variance Extracted (AVE). Off-diagonal elements are Pearson correlations between variables. For discriminant validity, diagonal elements should be larger than off-diagonal elements. All correlations are significant at 1% level (two-tailed).

Taken together, the previous tests indicate that the psychometric properties of the instruments are sufficiently adequate in an exploratory phase of research to enable interpretation of the structural model.

5.2.3 Structural model

Since PLS does not attempt to minimize residual item covariance, there is no summary statistic to measure the overall fit of models as in the case of other latent variable structural equation modeling techniques like LISREL, EQS or AMOS. Variance explained (R^2) and the sign and significance of path coefficients are used to assess the nomological validity of the model proposed in Chapter 3. PLS Graph generates standardized beta coefficients that can be interpreted as in ordinary multiple regression analysis. In Table 5.4, I report beta coefficients and *t*-values using the complete sample data across the three levels of analysis (n = 81). Each hypothesis formulated in the previous chapter corresponds to a path in the structural model. Bootstrapping technique (i.e. sampling with replacement method) provides a nonparametric approach to ascertain the stability and significance of the parameter estimates (Efron and Tibshirani, 1993). I computed the *t*-values on the basis of 500 bootstrapping runs. The explanatory power of the structural model can be evaluated by examining the R^2 value of the endogenous variables. The model accounts for substantial variance in predicting the different uses of EPMS. The variance explained for internal decision-making and control (USE_EPM_INT) was substantial with $R^2 = 0.74$, while $R^2 = 0.70$ is obtained in predicting use of EPMs for external accountability purpose (USE_EPM_EXT). R^2 values exhibit high levels also for other endogenous variables, particularly with respect to EMIS_AVA and EMIS_ACC. Taken as a group, the high R^2 values add support to the theoretical soundness of the proposed model and make the interpretation of the path coefficients meaningful. However, the lack of satisfactory discriminant validity exhibited by ENV_STR, EMIS_AVA and USE_EPM_INT recommends a cautious interpretation of the model's explanatory power. The high amount of variance explained by the parameter estimates could be ascribed to the conceptual overlapping among these constructs. Additional weaknesses linked to model specification and measurement properties will be presented and discussed in Section 5.7.

The results reflect a difference in the *direct* impact of environmental strategy implementation on the use of EPMs. A proactive environmental strategy seems not to affect the use of EPMs for internal control ($\beta = 0.173$, $p>0.1$), failing to support the proposition of a *direct* effect of strategy on MCS design formalized in Hypothesis 1a. In contrast, a proactive environmental strategy positively and significantly affects the use of EPMs for external accountability ($\beta = 0.531$, $p<0.01$), thus confirming the direct effect postulated in Hypothesis 1b. As predicted in Hypotheses 2a-d, strong support is found for the expected positive linkage between environmental strategy and the four dimension of EMIS sophistication.

Table 5.4 – Test of hypothesized relationships: standardized path coefficients and *t*-values (in parentheses)

	Paths to:									
	1.	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**	**10.**
	Adjusted R^2 for endogenous variables									
Paths from:	0.05	0.74	0.57	0.68	0.64	0.34	0.30	0.34	0.74	0.70
1. ENV_STR		0.869** (34.065)	0.742** (11.848)	0.827** (25.162)	0.814** (22.121)	0.588** (7.730)	-0.526** (7.954)	0.581** (7.208)	0.173 (1.147)	0.531** (3.187)
2. EMIS_AVA									0.643** (5.006)	0.427** (3.629)
3. EMIS_SCO									-0.061 (0.542)	0.006 (0.050)
4. EMIS_TIM									0.046 (0.287)	-0.277* (1.755)
5. EMIS_ACC									-0.106 (0.875)	0.145 (1.082)
6. EPM_SEN									0.141‡ (1.630)	
7. EPM_PRE									-0.139‡ (1.538)	
8. EPM_CON									-0.063 (0.537)	
11. SIZE_COM (control variable)	0.214* (1.868)	-0.060 (1.132)	0.050 (0.735)	-0.010 (0.176)	-0.073‡ (1.446)	-0.016 (0.167)	-0.067 (0.697)	-0.007 (0.079)	0.131** (2.504)	0.074 (1.156)

Notes: Sample size $n = 81$. The results are obtained with PLS Graph using 500 bootstrap runs. ** significant at 1% level (one-tailed); * significant at 5% level (one-tailed); ‡ significant at 10% level (one-tailed).

The four coefficients show positive and significant levels at $p<0.01$ with beta coefficients ranging from 0.588 to 0.827. On the contrary, regarding the paths among the four dimensions of EMIS sophistication and the use of performance measures (Hypotheses 3a-d), mixed evidence is provided. As expected, the availability of environmental performance measures is strongly associated with the use of these measures for both internal control (β = 0.643, $p<0.01$) and external accountability (β = 0.427, $p<0.01$). Contrary to expectations, there is no evidence of a significant relationship between the scope of EMIS and the use of EPMs. Further, timeliness of environmental information systems is not significantly related to the use of EPMs for internal control (β = 0.046, $p>0.1$). Contrary to the predicted direction, timeliness affects the use of EPMs for external accountability with a reversed sign (β = -0.277, $p<0.05$). Finally, results fail to support the posited positive link between the accuracy of EPMs and their use for both internal control and external accountability. Overall, the case for a mediating effect of environmental strategy on the use of EPMs through attributes of environmental information systems cannot be strongly supported. Only the availability of EPMs appears to indirectly affect the extent to which these performance measures are currently used for internal and external purposes. Further analysis about the mediation effect of EMIS dimensions is presented in the next section.

Hypothesis 4 proposed to explore the relationships between environmental strategy and specific attributes of performance measures derived from agency theoretic insights. The model posited a positive path linking environmental strategy and three newly developed constructs capturing the properties of sensitivity, precision and congruity of environmental performance measures. The results confirm the hypotheses postulating a positive relation concerning the property of sensitivity (β = 0.588, $p<0.01$) and congruency (β = 0.581, $p<0.01$) with environmental strategy. In contrast to the predicted direction, precision appears to be negatively related with environmental strategy (β = -0.526, $p<0.01$). The model thus confirms the unexpected sign between these two variables similarly to the correlation coefficients obtained in the bivariate correlation analysis presented in Chapter 4. Further, limited support is found for the expected relationships among properties of EPMs and their use for internal decision-making and control. Sensitivity is related in the predicted direction to the use of EPMs for internal control (β = 0.141) at 10% significance level. Precision of EPMs is associated to the use of EPMS but in the opposite direction from the theoretical assumption (β = -0.139) and at 10% significance level. It is plausible that the lack of support for the paths concerning EPMs precision reflects weaknesses in the instrument developed for this study. Additional and more articulated considerations on this point will be discussed in the limitations part of this section. Furthermore, concerning the link between congruity and use of EPMs, the PLS output displays a coefficient near to zero and statistically not significant.

Following other studies that relied upon partial least squares technique, control variables are generally introduced in the structural model to examine whether they affect interpretation of the results. In this study, the variable SIZE_COM (i.e. the natural logarithm of the total number of employees in the organization) was entered in the PLS model as covariate. It can be posited that the dimension of the organization might influence the relationships modeled in line with previous empirical research (cf. Bowen, 2000a). Three main arguments could suggest a positive relationship between organizational size and environmental responsiveness. First, several studies use organizational size as a proxy for organizational visibility. For instance, Henriques and Sadorsky (1996) argue that visible firms are more susceptible to public scrutiny and therefore are more likely to have implemented more proactive environmental strategy. The visibility explanation for a positive relationship between environmental responsiveness and firm size centres on the role of reputation capital and the potential effect on brand name of negative environmental information (cf. Konar and Cohen, 1997). Second, large firms are not only more visible but possess more financial resources that can be devoted to environmental issues. Excess resources or organizational slack can facilitate creative search behavior for appropriate environmental response options, and allow managers to experiment with ‘green’ organizational responses (Bowen, 2000b). The third rationale is based on economies of scale in environmental programs. Environmental economists suggest that scale economies are likely to occur for abatement technologies, which makes it relatively cheaper for large plants to introduce them (e.g. Dasgupta *et al.*, 2000). In larger organizations, the fixed costs associated with environmental-related investments can be distributed across a larger number of activities, making these types of investments more attractive. The results from the PLS model exhibit significant paths at conventional levels between size and ENV_STR (β = 0.214, p<0.05), and size and USE_EPM_INT (β = 0.131, p<0.05). A path coefficient close to zero (β = -0.073) is detected between size and accuracy of environmental information systems at 10% level of significance. Thus, it appears that size as control variable does not affect the interpretation of the results in the structural model.

Finally, two additional control variables were introduced in the model. The first one captures industry effects through a dummy variable of companies in the chemical sector, since they are the most represented in the sample (22.2% of respondents) and are considered as environmentally sensitive. Another control variable is a dummy variable that distinguishes companies subject to mandatory reporting (cf. Section 4.2.3). The path coefficients estimated from the alternative PLS model including these two extra control variables do not significantly vary from the previous results (data are not reported here), thus lending support to the robustness of structural paths.

5.3 Additional analyses

5.3.1 Mediating effects on EPM's use

Further analysis was conducted to ascertain the mediational roles played by EMIS attributes and EPMs properties in linking environmental strategy to the use of EPMs. I follow the *causal step approach* to assess mediation effects proposed by Baron and Kenny (1986) which specifies a series of tests about variable relationships in a casual chain. This approach can be traced back to the seminal work of Judd and Kenny (1981) and it is the most commonly used method to assess mediation models in behavioural and organizational research. The approach stipulates that four conditions must hold to establish that a mediation model exists (refer to Kenny, 2004; MacKinnon, 2004 websites on mediation analysis). The four conditions apply to a simplified three-variable mediation model in which the path between an antecedent variable and a dependent variable is mediated by an intervening third variable. The first condition claims that the antecedent variable must be related to the mediator variable. Second, the antecedent variable must be related to the dependent variable. Third, the mediator variable must be related to the dependent variable. Fourth, the effect of the antecedent variable on the dependent variable is significantly reduced upon the addition of the mediator. In order to confirm the mediational role played by EMIS sophistication and EPMs properties in the present study, a series of hierarchical nested models were performed in PLS (cf. Sarkar *et al.*, 2001; Ridings, Gefen and Arinze, 2002; Yi and Davis, 2003 for empirical papers employing PLS following the same procedure). The output of the PLS analysis reported in Table 5.4 reveals that the first condition is satisfied for the four dimensions of EMIS and for the three EPMs properties. I assessed the effects between environmental strategy and these variables by estimating a separate PLS model. The analysis reported in the Appendix F (Table F.1 Step 1) suggests that the beta coefficients are all significant, thereby satisfying the first condition for a mediation effect. The second condition requires testing the presence of a direct effect of the antecedent variable (*environmental strategy*) on the dependent variable (*use of environmental performance*). Two separate models were tested including only a direct link between environmental strategy and respectively use of EPMs for internal control and use of EPMs for external accountability. The results reported in Appendix F (Table F.1 Step 2a and Step 2b) indicate that environmental strategy positively affects the use of EPMs for internal control and external accountability with a direct significant path, thereby lending support for the second condition for mediation. A PLS model with the uses of environmental performance measures as dependent variable assessed the third condition, requiring a significant effect between mediating variable and dependent variable. The findings displayed in Appendix F (Table F.1 Step 3a) confirm a significant positive relationship for EMIS_AVA and EPM_SEN on the use of EPMs for internal control. Contrary to expectations, EPM_PRE displays a negative sign significant at 5% level. When the direct effects are modeled with the use of EPMs for external accountability as dependent variable (Table F.1 Step 3b), a significant positive path of EMIS_AVA is found. In addition, accuracy of EMIS positively relates with USE_EPM_EXT at 5% level of significance. To assess the fourth condition, PLS output from the complete model presented in the previous section already exhibited that: 1) the direct path linking ENV_STR to USE_EPM_INT becomes insignificant; and 2) the direct path linking ENV_STR to USE_EPM_EXT remains significant at the 1% level, though with a notable reduction of the beta coefficient if compared with the unmediated model (from β = 0.801 to β = 0.531).

Taken together, the additional analysis shows that the necessary conditions for mediation recommended by Baron and Kenny (1986) hold differently when comparing the two types of EPMs use. It can be inferred that the availability of EPMs and perceived sensitivity of EPMs *fully* mediates the effects of environmental strategy on the use of EPMs for internal control. The total (significant) indirect effect of ENV_STR on USE_EPM_INT through EMIS_AVA amounts to β = 0.558 (= 0.869 x 0.643). Conversely, EMIS_AVA *partially* mediates the effects of ENV_STR on the use of EPMs for external accountability. Moreover, there is mixed evidence concerning the significant mediational effects found for EMIS_TIM and EMIS_ACC on the use of EPMs for external accountability. When comparing the complete model with results for the partial effects, it is noteworthy that the beta coefficient for EMIS_TIM is significant in the complete model but becomes insignificant in the direct model. The reverse argument applies for EMIS_ACC, which is significant in the direct model but becomes insignificant in the complete model. In summary, marginal support was found for the proposed model's assumption that the effects of environmental strategy implementation on the use of EPMs for internal control and external accountability are fully accounted for by its indirect effect through characteristics of EMIS and EPMs properties. Specifically, only availability of environmental performance measures appears to fully mediate the effects of environmental strategy for both internal and external purposes.

5.3.2 Alternative model specifications

Additional *post hoc* analysis was conducted in the attempt to further interpret the model and eliminate potential confounding results. At first, I have tested the same hypothesized relationships at different levels of analysis (cf. Luft and Shields, 2003). The paths specified in the previous section have been tested using a reduced sample (n = 53) that employs data collected at divisional and operational level only (refer to Table E.4 in Appendix E). It can be argued that the linkages posited by the model might empirically vary at different level of analysis. From the results exhibited in Table F.2 in Appendix F, it appears that the results are robust across levels except for three paths concerning USE_EPM_EXT. First, the direct effect of ENV_STR on USE_EPM_EXT that was significant for the complete sample becomes insignificant in the model at lower levels of analysis. Hence, the indirect path from environmental strategy to the use of EPMs is fully mediated by the availability of environmental metrics. Second, the timeliness of EMIS is no longer significantly (negatively) related to USE_EPM_EXT. Third, the path linking accuracy of EPMs to USE_EPM_EXT becomes significant. Hence, it can be posited that at lower organizational levels more importance is attributed to the reliability of the data that is externally disclosed. Overall, and similarly to the results exhibited for the complete sample, the empirical evidence at lower organizational levels adds limited support to the conceptual model developed in this study. Contrary to most expectations, the availability of EPMs appears the only variable that significantly affects the use of environmental performance measures. It is also worth noting that the mediating effect found in the previous section by EMIS_AVA exhibits a stronger role using the reduced sample if compared with the complete sample model.

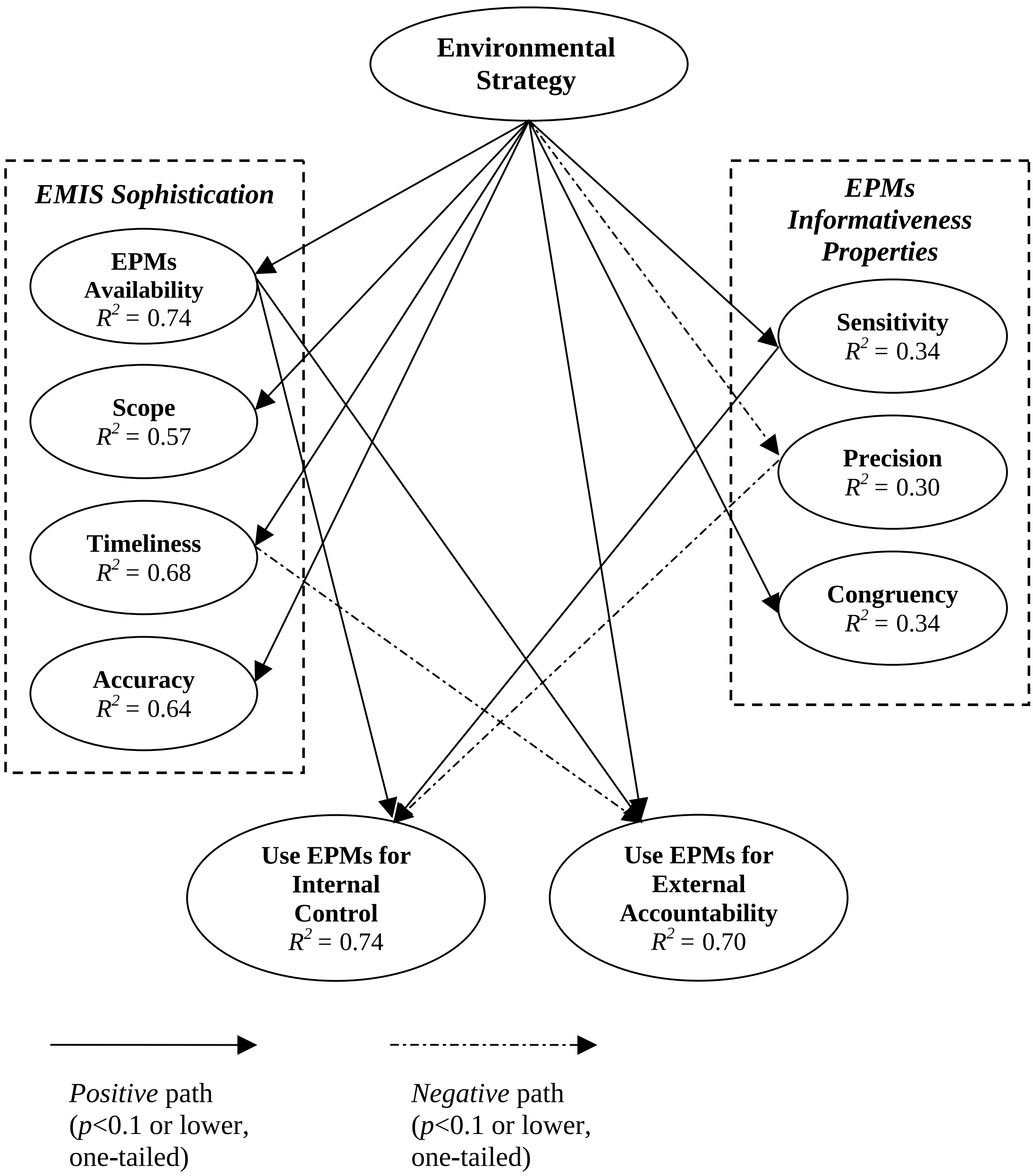
As additional analysis, I estimated a model in PLS with the use of EPMs for decision-control (USE_EPM_DC) as dependent variable. The objective was to test whether the weak empirical support to the theoretical expectations were due to an incorrect specification of the model. Recall the argument from Section 3.2.1 that the two uses of management accounting information (decision-*making* and decision-*control*) have been usually disentangled in prior management accounting studies (cf. Sprinkle, 2003). On the other hand, in this study it was decided to explore both uses under a unified construct (USE_EPM_INT). Prior research has particularly focused on the use of performance measures for decision-control as reviewed in Section 2.3.1. In this respect, it can be argued that the hypothesis development could have referred uniquely to predictions concerning decision-control purposes, particularly with regards to the conceptual linkages with the agency theoretic hypotheses (Hypotheses 4a-c and Hypotheses 5a-c). The construct USE_EPM_DC attempted to capture the extent to which environmental performance measures are used for performance evaluation and reward systems. The results of the model displayed in Table F.3 in Appendix F paralleled findings exhibited in the model discussed in Section 5.2.3. It appears that use of EPMs for decision-control is positively and significantly affected by environmental strategy implementation. In addition, there is evidence of an indirect effect of environmental strategy implementation on the use of EPMs through 1) the availability of adequate information systems that generate these types of performance measures, and 2) an increased sensitivity of the performance measures. Furthermore, while environmental strategy positively influences the other attributes of EMIS and EPMs properties (except for the *precision* construct which shows a significant path but in the opposite direction than predicted), no support is found for the effects of these variables on the use of EPMs for decision-control. In sum, when only performance evaluation and control purposes are included in the model as dependent variable, the proposed relationships among environmental strategy, EMIS sophistication and EPMs properties only confirm a mediating role of *availability* of environmental performance measures in explaining the use of these metrics.

5.4 Discussion of findings

The results of the survey support the rationale that the intensity of environmental management practices is an important antecedent to explain extent and manner of use of environmental performance measures. The PLS structural model with significant paths is displayed in Figure 5.1. There is evidence that the direct effect linking environmental strategy on the use of environmental performance measures for external accountability purposes was positive and significant. The analysis thus suggests that corporate disclosure policies about environmental-related information serve as a signaling mechanism towards external audiences that are directly influenced by internal implementation of environmental management practices. The increased use of environmental performance measures for external accountability may help improve the reputation of a corporation in accordance with arguments from legitimacy theory. In turn, disclosure policies may be motivated by strict economic arguments, with disclosure decisions being influenced by outsiders' knowledge about a firm's environmental management proactivity, but also its exposure to media, NGO's and other stakeholders. The results emphasize the need to expand the environmental accounting research focused so far on external effects of environmental disclosure and to include internal (*inside-out*) effects. Further, the findings do not support the existence of a direct path linking environmental strategy and the use of EPMs for internal control. It appears that this effect is fully mediated by some intervening performance measure attributes referring respectively to EMIS sophistication and EPM's properties.

First, the results indicate that firms aiming at implementing a proactive environmental strategy rely more extensively upon management information systems that generate (i.e. systematically report internally) environmental performance measures. Consistently with expectation, companies associated with a higher intensity of environmental management practices tend to develop a wider range of environmental performance measures. The increased availability of these measures points at an increased reliance on non-financial metrics, particularly in terms of input and efficiency measures, and also financial performance measures that translate environmental effects into monetary information. The survey thus provides a unique contribution to the understanding of the current development of an innovative typology of performance measures. Taken individually, the attributes of *scope, timeliness* and *accuracy* that are associated with the environmental information system also significantly increase with the intensity of an environmental strategy. These results add to the arguments rooted in the contingency-based tradition of management accounting research which contend that a *Cartesian/congruence* type of fit should be present between strategic choice and design of management accounting systems (cf. Fisher, 1995; Donaldson, 2001; Chenhall, 2003; Gerdin and Greve, 2004).

Figure 5.1 – Output of PLS structural model (same data as Table 5.4)



With regard to the hypotheses concerning the informativeness properties of EPMs, I find evidence of the association between environmental strategy and three performance measure properties. It can be inferred that a more proactive environmental strategy tends to positively affect the degree to which environmental performance measures are perceived as *sensitive*. It seems plausible that the ability of environmental performance measures to capture managerial decisions increases with the intensity of environmental management practices. The same evidence holds for the perceived *congruency* of the performance measures, though the results need to be carefully interpreted because of the possibly weak psychometric properties of the instrument developed. On the other hand, the expected positive link between strategy and precision in performance measures was not supported and the data suggested instead a significant negative relationship. This finding should be also treated with caution, as the counterintuitive result is likely to be due to the low content validity of the instrument developed for the present study. It is plausible that the items intended to measure *precision* in the performance measures captured the perceived *environmental uncertainty* with regards to the environmental management of a firm's operations. If this speculation is accepted, it appears that the perceived uncertainty associated to environmental-related performance is *positively* related to the extent of proactivity of the environmental strategy and the EMIS sophistication. In other words, the variable labelled with *precision* could be modeled as an antecedent of environmental strategy, with significant direct effects on the use of EPMs. As such, this interpretation would explain the negative relationship between the proposed instrument and the other constructs.

Furthermore, the paths exploring the relationship between sophistication and informativeness of environmental performance measures on their use for internal control and external accountability are found to be partially significant. Only the variable measuring the *availability* of environmental performance measures is significantly associated with their use for both internal and external purposes. Although environmental strategy does not have a direct effect on the use of internal control, it does show an indirect effect through the mediating role of available performance measures. Stated differently, it can be inferred that the availability of EPMs is a necessary (but not sufficient) condition for the use of performance measures. Also, the expectation that the use of performance measures for external accountability is a function of its availability is strongly confirmed by the structural model. On the contrary, the results do not provide a significant association between the other design features characterizing management information systems. Interestingly thus, although more proactive levels of environmental strategy tend to translate into enhanced scope, timeliness and accuracy of the measures, these design attributes of MCS do not seem to affect the extent of use of EPMs for decision making and control. These counterintuitive results are intriguing in that they might suggest a discrepancy between perceived sophistication of a management information system and the *usefulness* of the information made available. The results lends support to prior findings of so-called 'measurement gap' in extant performance management systems (cf. Ittner and Larcker, 2001; Ittner *et al.*, 2003b). Studies involving the use of EPMs at different organizational levels and functions are needed to explain this issue further. As with the predictions concerning the sophistication of EMIS and the use of EPMs for external accountability, only the effect of *timeliness* appears significant but with reversed sign. Apparently, decisions concerning the extent of external disclosure of environmental performance are negatively – although weakly – associated with frequency and speed of internal environmental reporting. Therefore companies having more timely environmental-related information tend to be more reluctant to use it in their corporate disclosures. As previously emphasized, further investigation is needed to explore the use of EPMs for external accountability purposes in combination with internal MCS attributes.

The test of the hypotheses concerning informativeness properties provides partial support to the path connecting *sensitivity* to the use of EPMs for internal control. Consistently with agency theoretic insights, the data confirms that companies tend to rely upon performance measures that are more informative of managers' effort. Contrary to expectation, *precision* is negatively associated with the use of environmental performance measures. The same interpretation of the plausible incorrect instrument specification applies here as well. Another unexpected finding concerned the lack of effect of *congruency* on the use of EPMs. This result might be due to problems in establishing satisfactory levels of content validity for the instrument developed for the present study.

To conclude, the nomological network developed for this study conceptually posited that EMIS sophistication and EPMs properties are mediating variables between environmental strategy and the use of environmental performance measures. The rationale of this argument is that the implementation of environmental strategy by itself cannot ensure the use of environmental performance measures. In contrast, appropriate performance measurement systems showing enhanced levels of quality and relevance are needed before they can be used for internal control and external accountability purposes. Overall, the results from the survey study suggest that implementing proactive environmental management systems simultaneously influences environmental performance measurement design and use attributes. Interestingly, there is evidence of a differential effect on EPMs use. While the effect of environmental strategy on the use of EPMs for external accountability is primarily direct, its effect on the use of the same metrics for internal control is mediated through sophistication of EMIS. By decomposing this effect in single paths, only the variable *availability of environmental performance measures* is significantly affected by a proactive environmental strategy, and in turn, significantly enhances the use of environmental performance measures for both internal control and external accountability. In contrast, results concerning the mediating paths of other EMIS attributes that were derived from behavioral-based management accounting literature are not significant. The only significant association refers to the dimension of *timeliness*, which is unexpectedly negatively related to the use of EPMs for external accountability.

Finally, the theorized effects of performance measure properties on their use for internal control only support a weak mediating effect of *sensitivity* of EPMs on the use of these measures for internal control. It is noteworthy that the perceived informativeness properties of EPMs are weakly associated with their use for decision making and decision control, despite their significant relation with environmental strategy (at least for the paths concerning sensitivity and congruence). It appears that the perceived informativeness of the environmental performance measures increases with more proactive posture of environmental strategy, suggesting the presence of environmental performance measures in the business model (Ittner and Larcker, 1998b, 2001; Malina and Selto, 2001; Ittner and Larcker, 2003; Malina and Selto, 2004). At the same time, however, weak empirical evidence supports the predictions derived from economics-based literature in performance measurement choice. According to these predictions, it would be unusual to observe a performance measure with substantial positive coefficient in the business model, but a zero coefficient in the compensation model. This would occur only if the use of these measures imposes too much risk on a risk-averse agent (Datar *et al.*, 2001; Ittner *et al.*, 2003a). It can be suggested that this research setting exhibits this type of attribute. For instance, uncertainty is pervasive in terms of measuring performance, with the consequence that it may be difficult for the agent to share the environmental risks and deliver the appropriate level of environmental performance (cf. Campbell *et al.*, 2000; Goldsmith and Basak, 2001). The positive association between environmental strategy and the instrument presumed to measure *precision* of EPMs confirms this speculation.

5.5 Test of Hypothesis 6 about consistency of use

Hypothesis 6 investigated whether companies classifiable as environmentally reactive tend to use EPMs with more emphasis on external accountability purposes than proactive companies. In Section 4.6.3, the analysis of variance comparing the means of USE_EPM_INT (mean of reactive companies = 2.19; mean of proactive companies = 4.35) and USE_EPM_EXT (mean of reactive companies = 2.27; mean of proactive companies = 4.95) indicated a significant difference between the uses when comparing reactive with proactive companies. I performed an additional analysis computing the Pearson correlations between the two uses by splitting the sample at the mean score of the variable ENV_STR. I obtained that the correlation for the group of reactive companies ($n = 40$) is $r = 0.256$ and statistically not significant at the 5% level ($p = 0.111$). The correlation for the group of proactive companies ($n = 37$) is $r = 0.475$ and statistically significant ($p = 0.003$). A Fisher's z-test was computed following the formula in Cohen and Cohen (1983) to assess whether there is a significant difference between the two correlation coefficients. The Fisher's z-score $z = 1.072$ ($p = 0.142$) indicates that the null hypothesis positing that two correlation coefficients obtained from independent samples are equal cannot be rejected. Apparently, the *between-organization* results provide limited evidence of a significantly different use of EPMs for internal control versus external accountability.

To better address the hypothesis about consistency of use, I needed a method that could also provide evidence of the *within-organization* differences of use. Therefore, I explored the extent to which environmental performance measures are used for internal control and compared the score obtained with the use of the same measures for external accountability. The difference (or 'measurement gap' in Ittner and Larcker, 2003) between the two uses calculated for each respondent provides an indication of the consistency of use of environmental performance measures for internal control and external accountability. I expected to observe a higher consistency of use for companies with a more proactive environmental strategy than in companies that exhibit a more reactive environmental strategy. To test this hypothesis, I dichotomized the variable environmental strategy at the mean and computed for the two samples the unit-weighted average of the *within-respondent* difference between use for internal control and external accountability. The difference was computed by subtracting for each subject the averaged scores for USE_EPM_INT from the averaged scores of USE_EPM_EXT. This means that positive(negative) signs resulting from the difference would mean a higher(lower) use for internal control in comparison with external accountability. The theoretical range of this variable is from -6 to 6 (being the theoretical range of each instrument comprised on a scale from 1 to 7), with scores nearer to 0 implying more consistent use of environmental performance measures.

The results indicate that companies with a more reactive environmental strategy (n = 40) show a mean for the consistency of use equal to -0.0775 (s.d. = 1.327). It appears that, on average, the use for internal control and external accountability are substantially consistent in presence of a reactive environmental strategy. Conversely, a slightly 'measurement gap' (cf. Ittner and Larcker, 2001 and Section 3.2.1) is detected with regards to the more proactive companies (n = 37), as they exhibit an average difference in the use of EPMS equal to -0.605 (s.d. = 1.121). The findings show therefore that, on average, more proactive companies tend to rely more on environmental performance measures for external purposes than for internal control use. It seems that the predicted higher consistency for more proactive companies is actually reversed, so that higher consistency of use (i.e. less difference between external and internal use) occurs in more reactive companies. Subsequently, I carried out an analysis of variance test to confirm whether this difference is significant. I performed a Levene test (Norušis, 2003) as a pre-test to determine whether the group variances are approximately equal (i.e., whether the homogeneity of variance assumption is satisfied). The observed significance level for the Levene test is 0.698, thus confirming the null hypothesis that the two populations have equal variances. Further, the analysis of variance shows that the difference between the consistency scores is not significant at conventional level (p = 0.064). In conclusion, a 5% level significant difference of mean levels about consistency of use of environmental performance measures cannot be inferred from the data. The expectation concerning a higher consistency of within-organization use for companies displaying a more proactive environmental strategy was only weakly supported by the data.

Finally, following the same procedure, I tested whether an inconsistency of use emerged when comparing the use of environmental decision-making with the use of the same measures for decision-control. I computed a new variable as a difference between use for decision-control (USE_EPM_DC) and use for decision-making (USE_EPM_DM) for each observation (*within-organization* analysis). The results indicate that companies with a more reactive environmental strategy (n = 40) show a mean for the consistency of use between decision-control and decision-making equal to -0.945 (s.d. = 0.863). This was slightly lower than the group of proactive companies (n = 37), as they exhibit an average difference of -1.049 (s.d. = 0.948). Similarly to the previous analysis about consistency between internal and external purposes, I conducted an analysis of variance test. The Levene's test exhibits a score of 0.732, which is not significant (p = 0.395), thus enabling to accept the null hypothesis that the two populations (reactive versus proactive companies) have the same variance. The analysis of variance shows that the difference between the consistency scores is not significant (p = 0.617), therefore confirming the presence of a consistent use of EPMs for decision-making and decision-control between reactive and proactive companies.

5.6 Effects of environmental performance measurement systems

Hypothesis 7 posited an indirect effect of environmental strategy on environmental performance through the use of EPMs for internal control. Underlying this assumption is the rationale that proactive environmental companies positively affect the level of environmental performance through increased reliance on results control systems that use environmental performance measures. I will test Hypothesis 7 by examining the mediating role of the use of EPMs for internal control in a three-variable model as depicted in Figure 5.2. The statistical analysis of such a model allows testing a *contingency/mediation*-fit (cf. Gerdin and Greve, 2004) by using a *causal step approach* suggested by Baron and Kenny's (1986, cf. Section 5.3.1). More recently, researchers have focused on additional statistical approaches to test mediation models as summarized by MacKinnon, Lockwood, Hoffman, West and Sheets (2002). Their review paper identified fourteen different methods from a variety of disciplines that were proposed to test path models involving intervening variables. The procedures vary in their conceptual basis, the null hypothesis being tested, their assumptions and statistical methods of estimation. In this study, I complement the *causal step approach* with the *product of coefficient method* developed by Goodman (1960) and Sobel (1982), and following the suggestions in MacKinnon, Warsi and Dwyer (1995) and MacKinnon *et al.* (2002). This approach has its origins in sociology and is based on the product of coefficients of the indirect effects among variables.

Starting from the *causal step approach*, and similarly to the prior analysis in Section 5.3.1, the first step to establish mediation according to Baron and Kenny (1986) requires a significant relationship between the independent variable (in this model ENV_STR) and the dependent variable (ENV_PER). In Figure 5.2, this link is represented as path a_1. The regression analysis carried out using the complete data sample (n = 71) displayed in Table 5.5 (Step1) indicates that this condition is satisfied (β = 0.853, p<0.01)[4]. The second step assesses the relationship between independent variable and mediating variable (USE_EPM_INT), depicted by path *b*. The beta coefficient is positive and significant (β = 1.216, p<0.01), lending support to the direct effect of ENV_STR on USE_EPM_INT that was established in the previous section. Further, step three is tested by regressing ENV_PER on the mediating variable (USE_EPM_INT). The results indicate a significant coefficient for the path c_1 (β = 0.517, p<0.01). The fourth and last condition requires introducing in the same regression model independent and mediator variable. It appears that the coefficient for ENV_STR (path a_2) is lower (β = 0.595, p<0.01) if compared with Step 1, though it remains highly significant. The effect of USE_EPM_INT on ENV_PER (path c_1) is lower but it remains significant (β = 0.213, p<0.01), thereby *partially* satisfying the fourth condition for a mediational model. Since the effect of environmental strategy is not reduced to zero in presence of the mediating variable (USE_EPM_INT), it cannot be inferred that the use of EPMs for internal purposes *fully* mediates the relationship between ENV_STR and ENV_PER.

Figure 5.2 – Mediation model about environmental performance with *unstandardized* coefficients paths (standard error in parentheses)

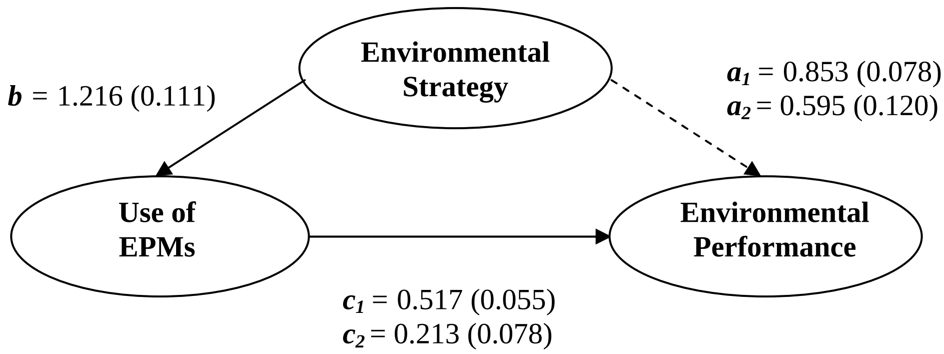


Table 5.5 – Analysis of mediation effects following the four-step approach by Baron and Kenny (1986)

Step 1): Direct effects of ENV_STR on ENV_PER (path a_1)

Independent variable	*Beta coefficient*	*Std. Error*	*t-value*	*Sig.*
Constant	0.467	0.242	1.933	0.057
ENV_STR	0.853	0.078	10.883	0.000

Notes: sample size n = 71. F = 118.45 (p<0.00). R^2 = 0.632.

Step 2): Direct effect of ENV_STR on USE_EPM_INT (path b)

Independent variable	*Beta coefficient*	*Std. Error*	*t-value*	*Sig.*
Constant	-0.310	0.342	-0.907	0.367
ENV_STR	1.216	0.111	10.937	0.000

Notes: sample size n = 77. F = 119.61 (p<0.00). R^2 = 0.615.

Step 3): Direct effect of USE_EPM_INT on ENV_PER (path c_1)

Independent variable	*Beta coefficient*	*Std. Error*	*t-value*	*Sig.*
Constant	1.240	0.200	6.189	0.000
USE_EPM_INT	0.517	0.055	9.378	0.000

Notes: sample size n = 74. F = 87.95 (p<0.00). R^2 = 0.550.

Step 4): Indirect effect of ENV_STR on ENV_PER through USE_EPM_INT (paths a_2 and c_2)

Independent variable	*Beta coefficient*	*Std. Error*	*t-value*	*Sig.*
Constant	0.516	0.232	2.230	0.029
ENV_STR	0.595	0.120	4.954	0.000
USE_EPM_INT	0.213	0.078	2.745	0.008

Notes: sample size n = 71. F = 68.59 (p<0.00). R^2 = 0.669.

In other words, the results provide evidence of a partial effect of environmental strategy on environmental performance through the mediating role of the use of environmental performance measures for internal control.

The second approach adopted here (*product coefficient method*) consists of estimating a test of the statistical significance of the indirect effect through the mediator variable. Referring to the Figure 5.2, the following equation can be specified:

$$r_{xy} = a_2 + b \ x \, c_2 + \textit{spurious effects,}$$

where r_{xy} is the observed zero-order correlation between mediator (USE_EPM_INT) and performance variable (ENV_PER) (Venkatraman, 1989:430). Because this involves testing a product of two regression coefficients, a standard t-test cannot be adapted. The relative proportion of the two effects – indirect (b x c_2) versus direct (a_2) – provides instead an index of the relative effect of fit (namely, indirect effect) versus the direct effect. Statistical corroboration of the indirect effect can be provided through a test of the significance of the intervening variable effect, by dividing the estimate of the indirect effect by its standard error and comparing this value to a standard normal distribution to assess the significance of the intervening variable. There are several variants of the standard error formula based on assumptions and order of derivatives in the approximations as reviewed in reviewed in MacKinnon *et al.* (2002). Among these formulas, I computed a Sobel test, which allows testing the significance of the intervening variable effect by dividing the estimate of the intervening variable effect by its standard error and comparing it to a standard normal distribution. The Sobel test and two of its variants (the, so-called, Goodman-I test and the Goodman-II test) appeared to perform best in a Monte Carlo study (MacKinnon *et al.*, 1995), and converge closely with sample sizes greater than fifty observations. The values of these statistics were computed using the formulas in MacKinnon *et al.* (2002). They indeed fully matched with the results from the interactive calculation tools made available in Internet by Preacher and Leonardelli (2004) and Cheung (2004). The tests are all significant at $p<0.01$ level (Sobel test: $z = 2.65$, $p = 0.008$; Goodman (I) test $z = 2.64$, $p = 0.008$; Goodman (II) test $z = 2.66$, $p = 0.008$), thereby lending support to the existence of a *partial* mediating effect of USE_EPM_INT between ENV_STR and ENV_PER. This method confirms therefore that there is a positive indirect effect of environmental strategy on environmental performance that remains significant after controlling for the use of environmental performance measures for internal control. The latter variable is nevertheless a significant mediator of the relationship.

To complete the analysis, I explored the performance implications of environmental performance measures by introducing the variable *environmental performance* in the structural equation model tested in the first part using PLS. The results of the more complete nomological network are reported in Appendix F in Figure F.1 (only significant paths are depicted with an indication of the significance levels). When environmental strategy, design, use and effects of environmental performance measures are simultaneously taken into account, the findings overall confirm the results from the previous sections but highlight an interesting finding. The results indicate that the indirect effect linking environmental strategy on the use of environmental performance measures is captured away by another mediating path through the availability of EPMs. In addition, the direct effect of environmental strategy on environmental performance remains significant like previously demonstrated in the reduced three-variable mediating model.

In conclusion, findings applied to both simplified (three-variable contingency-type of model) and extended network (structural equation model) show that the implementation of environmental strategy directly affects the levels of environmental performance. Concurrently, a significant indirect effect can be detected from environmental strategy to environmental performance through the availability of environmental performance measures and their use for internal control.

5.7 Limitations of the survey study and motivation for the case study

In this chapter, I tested a series of hypotheses concerning determinants of use and performance effects of environmental performance measures. The nomological net developed for this study addressed specific factors to explain design and use attributes of environmental performance measurement systems by integrating two streams of literature in management accounting research about performance measurement choice. The results obtained from a sample of 81 financial managers and controllers employed in Dutch manufacturing companies are summarized in Table 5.6.

The findings have important implications in clarifying strategy-management control systems interrelationships in the empirical setting of environmental management. Despite the insights and understanding gained, several limitations of this exploratory study should be considered when interpreting its results. The limitations relate to three main issues: (1) survey design; (2) measurement instruments; and (3) specification of the structural model. These limitations are addressed in turn.

As with survey design limitations, in absence of archival data concerning the phenomenon of interest a survey was deemed a necessary research method to empirically explore the diffusion of environmental performance measurement systems. It should be recalled from Chapter 4 that the survey design was complicated by the simultaneous execution of three interrelated research projects. This circumstance constrained the choice of the sample and affected the final sample size. More importantly, the survey results highlighted a problem of ineligibility of a significant portion of the respondents sampled. This problem was inherent to the selection of respondents from members of an accounting professional institution for a topic that can be expected a priori as non-accounting-related. This study is also restricted in that it uses single informants per organizations. Alternatively, another approach would involve data collection from multiple respondents (cf. Kumar, Stern and Anderson, 1993). One possible extension would be to address respondents that are more acknowledgeable about environmental management practices, like, for instance, environmental managers or manufacturing managers. This procedural remedy would probably enhance the reliability of the measures and reduce the common method bias associated with a single respondent (Posdakoff, MacKenzie, Lee and Posdakoff, 2003).

Table 5.6 – Summary of survey results

Hypotheses	***Predicted sign***	***Results***
H1a: ENV_STR → USE_EPM_INT	Positive	Not supported
H1b: ENV_STR → USE_EPM_EXT	Positive	Supported
H2a: ENV_STR → EMIS_AVA	Positive	Supported
H2b: ENV_STR → EMIS_SCO	Positive	Supported
H2c: ENV_STR → EMIS_TIM	Positive	Supported
H2d: ENV_STR → EMIS_ACC	Positive	Supported
H3a: EMIS_AVA → USE_EPM_INT	Positive	Supported
H3b: EMIS_SCO → USE_EPM_INT	Positive	Not supported
H3c: EMIS_TIM → USE_EPM_INT	Positive	Not supported
H3d: EMIS_ACC → USE_EPM_INT	Positive	Not supported
H3e: EMIS_AVA → USE_EPM_EXT	Positive	Supported
H3f: EMIS_SCO → USE_EPM_EXT	Positive	Not supported
H3g: EMIS_TIM → USE_EPM_EXT	Positive	Not supported
H3h: EMIS_ACC → USE_EPM_EXT	Positive	Not supported
H4a: ENV_STR →EPM_SEN	Positive	Supported
H4b: ENV_STR → EPM_PRE	Positive	Not supported
H4c: ENV_STR → EPM_CON	Positive	Supported
H5a: EPM_SEN → USE_EPM_INT	Positive	Partially supported
H5b: EPM_PRE → USE_EPM_INT	Positive	Not supported
H5c: EPM_CON → USE_EPM_INT	Positive	Not supported
H6: *proactive* companies use EPMs more consistently than *reactive* companies	Significant difference	Partially supported
H7: ENV_STR → USE_EPMs → ENV_PER	Positive indirect effect	Partially supported (*partial* mediation)

Another limitation concerned the cross-sectional design inherent to a survey-based research method. The study does not allow detection of causal relationships but only static associations among variables. This limitation is particularly relevant if contingency-based relationships need to be tested, as it appears problematic to infer fit-misfit situations by relying upon cross-sectional data (cf. Donaldson, 2001; Hartmann, 2005). An additional limitation regarding the survey design is related to the level of analysis. The sample selection procedure did not allow addressing respondents employed at the same organizational level. Future survey-based study should address this drawback by preferably focusing on the same level of analysis (cf. Luft and Shields, 2003). Another weakness is that the survey is limited by its focus on the manufacturing sector, provided that the use of environmental performance measures seems to increasingly diffuse in service organizations. Exploring the conceptual model in these companies would be particularly fruitful in the future. A final concern regarding the survey design refers to the length of the questionnaire. A shorter questionnaire would have probably reduced respondents' fatigue and enhanced the response rate.

With regard to the instruments used, although the measurement model suggests acceptable results for an exploratory study, its interpretation is limited by the weak psychometric properties displayed by some variables. In absence of established instruments, the study attempted to develop reliable and valid constructs by relying upon prior literature and multivariate statistical methods. Nevertheless, concerns remain for a number of variables. In particular, discriminant validity remains the main limitations for the concepts attempting to capture *environmental strategy*, *use of EPMs* and *environmental performance*. Future studies should use refined measurement instruments in larger samples so that the stability and generalizability of the results can be improved. Moreover, enlarged sample size would open up the possibility of using structural equation models in a confirmatory approach. Another important immediate issue requiring further conceptual and practical developments refers to the measurement of environmental performance. The survey study relies upon an all-inclusive perceptual measure with limitations inherent to common-method bias. Considerable work is needed to build archival data of sufficient reliability in this field, particularly in the European context.

Finally, with regard to model specification, the survey tested a conceptual set of relationships in a parsimonious way. There may be omitted variables in the theoretical model. Extensions to this study could examine the extent to which contextual variables influence the predicted relationships. Alternatively, it is important to extend the nomological network to include additional organizational design features and their linkages with MCS design and use attributes. Another *caveat* of this research is the assumption of unidirectional relationships between the variables. It is possible, however, that some relationships are in the opposite direction, or even reciprocal. This study is also restricted by its focus on the dependent variable *use of EPMs* as an *absolute* variable. In other words, the measurement instrument elicited information exclusively about the use of environmental performance measures. An alternative specification would denote instead a *relative* use, to gather evidence on how environmental performance measures are designed and used in scorecard-type of measurement systems mixing financial and non-financial performance measures. Finally, provided that endogeneity cannot be excluded in the present model specification, problems of biased estimators are likely to be present (cf. Chenhall and Moers, 2004).

In the next chapter, I complement the empirical analysis of the first part of the dissertation by means of a qualitative case study. The case study is designed as explanatory (cf. Keating, 1995; Ryan *et al.*, 2002; Yin, 2003) since it attempts to test the plausibility of the conceptual model developed in Chapter 3 about determinants of environmental performance measurement systems. The proposed relationships among the variables examined in the model are analyzed in a manufacturing company operating in the chemical sector. Evidence from fieldwork is expected to bring to light shortcomings in the conceptual model, providing directions for its extensions or modifications, as well as to make sense of the empirical results obtained from the cross-sectional survey. In particular, the field study allows for a longitudinal analysis of the casual relationships examined in the survey. The case enables a more thoroughly understanding of the casual paths illustrated in the nomological network in order to cope with the limitations associated with a cross-sectional empirical method. By approaching the nomological network with an elapsed temporal perspective, the case provides a wider analysis of how internal and external factors influenced the *processual* aspects regarding the integration of environmental performance measures into traditional, financial oriented management accounting systems. As emerged from the literature review in Chapter 2, there is a paucity of academic research that investigates the dynamics of change of (management) accounting systems in response to companies' internal and external environmental agenda (Adams, 2002; Gray, 2002; Owen, 2004). A detailed understanding of the processes through which change in this area could be generated is only now starting to be considered in environmental accounting research (e.g. Larrinaga-Gonzalez and Bebbington, 2001). The case study draws therefore on prior qualitative research about management accounting change that examined organizational dynamics related to the implementation of innovative forms of (management) accounting and control systems (e.g. Chenhall and Langfield-Smith, 1998a; Vaivio, 1999b; Burns, 2000; Kasurinen, 2002; Soin, Seal and Cullen, 2002; Chenhall and Langfield-Smith, 2003).

Endnotes Chapter 5

[1] ICR is calculated by squaring the sum of loadings, then dividing it by the sum of squared loadings plus the sum of the error terms.

[2] AVE is calculated by summing the squared loadings, then dividing it by the sum of squared loadings plus the sum of the error terms.

[3] The Pearson correlation coefficients presented in Table 5.3 are slightly different than the correlation coefficients reported in Table E.7 in Appendix E. The reason is that in the latter I computed unit weighted means to obtain correlations among the constructs, while in the former the coefficients are computed using the factor scores of the latent variables automatically generated in PLS Graph. However, a closer examination of the matrixes does not reveal remarkable differences in the sign or the significance level.

[4] The analysis was performed using SPSS 11.0. Contrary to PLS Graph, SPSS allows the computation of standard error of the beta coefficients in regression analysis. The beta coefficients displayed are the unstandardized values in line with the indications suggested, among others, by Preacher and Hayes (2005) to appropriately conduct the Sobel test.

CHAPTER 6
CASE STUDY

6.1 Introduction

Referring to the findings of the survey study presented in Chapter 5 as input, I address in this chapter the three research questions of this dissertation by using insights from a longitudinal case study. The objective of the case study is twofold. First, the case complements the survey study. The extent to which the conceptual model contributes to a satisfactory explanation of the use of environmental performance measurement system in the case company would be indicative of its explanatory power (Yin, 2003). In addition, three research questions (SRQs, i.e. survey-related research questions) will be addressed to cope with the survey study limitations (in brackets I indicate the weakness as emerged from the previous discussion in Section 5.4):

SRQa *Did the instruments developed for the survey study reflect valid measures of the constructs of interest?* (limitation of measurement model)

SRQb *Are the causal relationships posited by the model confirmed by examining them with a dynamic approach?* (limitation of structural model and survey design)

SRQc *Did the survey study appropriately capture a consistent use of environmental performance measures at different levels of analysis?* (limitation of structural model and survey design)

Second, the case seeks to extend our understanding of the dynamics that characterize the integration – or lack thereof – of environmental performance measures into traditional managerial control systems. A longitudinal case study is used as the basis of analysis to address the research questions formulated at the outset of the dissertation regarding processual aspects of environmental management accounting and control. The research questions were:

RQ3a *How do processual aspects of management accounting change affect the integration of environmental performance measures in traditional management control systems?*

RQ3b *What is the role of the accounting and control function in the integration process?*

The chapter is structured as follows. The next section describes the research method and the objectives associated with the case study. In Section 6.3, an extensive case description is provided to illustrate the organizational and contextual aspects that are relevant about the topic investigated. In particular, Section 6.3.4 is focussed on the process that characterized the implementation of a revised environmental performance measurement system in the case company (further labelled as the "environmental accounting project"). The main chronological events about the project, with the complexities and barriers encountered during its execution, are described as they unfolded over time during the investigation. In the second part of the chapter, I analyze and discuss the case and its implications for the model. In Section 6.4 attention is given to the theoretical variables of interest examined by the survey study and an attempt is made to establish plausibility in the model developed in Chapter 3 by addressing the survey-related research questions (SRQs). Subsequently, in Section 6.5 I will argue about the relevance of further examining the complex interplay between specific intra- and extra-organizational drivers that characterize the field of environmental management and accounting. I will specifically draw upon the evidence collected during the implementation of the environmental accounting project within DeltaChem discussed in Section 6.3.4 to address *RQ3a* and *RQ3b*. Finally, a discussion of the key findings and implications from the case study follows in Section 6.6.

6.2 Case study design

The case study in this dissertation can be defined as an *explanatory* case study (cf. Ryan *et al.*, 2002). In particular, according to the typology proposed by Keating (1995) in his classification of field studies in management accounting research, I develop a *theory illustration* case. The objective is to establish the plausibility of a specific theoretical perspective by demonstrating its capacity to illuminate some previously unappreciated aspects of (accounting) practices (two recent case studies using a similar approach are Van den Bogaard and Spekle, 2003 and Dekker, 2004). Rather than looking for verification or falsification of the conceptual model, I use the variables and the relationships investigated in the survey study to gauge the extent to which the model provides an explanation of the use of environmental performance measures. Accordingly, case study evidence will serve to make sense of the empirical data obtained from the survey results presented and discussed in Chapter 5.

In addition, the methodology employed in this chapter contains a longitudinal dimension. Studies with a longitudinal element in their design better allow the detection of causal relationships, the inference of data on processes, understanding of organizational change, and the inclusion of contextual constraints (cf. Ahrens and Dent, 1998). Longitudinal case studies have grown in popularity in accounting research in recent years as methods to tease out the cumulative characteristics of organizational change processes in management accounting (e.g. Vaivio, 1999b; Burns, 2000; Granlund, 2001; Kasurinen, 2002; Soin *et al.*, 2002; Ahrens and Chapman, 2004). This case study investigates the dynamics of change with respect to the implementation of an environmental performance measurement system. It generates insights on the reasons behind the motivation of the case company to shift towards a more refined performance measurement and reporting systems for environmental-related information. Both technical and organizational dimensions of performance measurement system development in the case company are addressed and an attempt will be made to embed the analysis in the linear model developed at the outset of the dissertation.

The case study was developed in partnership with a manufacturing company labelled under the disguised name of DeltaChem. A detailed disclosure agreement between the company and my university was signed to ensure confidentiality during the execution and reporting of the project. To ensure integrity of the data collection process, management of DeltaChem agreed at the beginning of the project that the company would review the research output to correct inaccuracies, but would not dictate the substance of neither the analysis nor conclusions of the study. It was also agreed that the company would retain the right to remove or disguise any internal sensitive data that would potentially damage the firm's competitive position.

DeltaChem is a producer of chlorine, alkali products and various other chemical derivatives. Its products are used in chemical, glass, detergent, pulp and paper, and plastic industries. DeltaChem is a business unit belonging to a multinational, multidivisional company headquartered in Europe. At the outset of the collaboration, the personnel employed at DeltaChem amounted to approximately 1,600 workers. In 2003, the turnover was about €550 million.

The case study developed within the research collaboration project was established with DeltaChem in January 2002. The dissertation presents the developments of the research project until the active part of the study finished in December 2003 and briefly reports about its latest development in 2004. It is important to point out that chronologically the case began prior to the design and administration of the survey that was presented in Chapters 3-5. The field study in DeltaChem could have been used in this dissertation as an exploratory study, with a primary function of theory development. In that case, it would have served another objective, namely as preparatory study that would have preceded the survey presented in the previous chapters. Instead, I opted to use the field study as an *illustrative* case, given its emphasis to relative strengths and limitations of the model developed and tested in Chapters 3-5. In addition, the longitudinal dimension of the case allowed a richer analysis and interpretation of the same model and hypotheses previously developed. In combination, survey and case method were expected to provide higher explanatory power and richer empirical insights than the survey study alone.

The research collaboration was initially solicited by the Quality, Health & Safety and Environment (QHSE) manager of DeltaChem as part of an on-going business unit program concerning improvement and harmonization of environmental management practices (see further in Section 6.3.3 for a more detailed description of the specific initiatives involved). The interest on the side of the company was to obtain an independently minded, academic advice on how to cope with (potential) technical and organizational problems related to performance measurement and control systems in the area of environmental management and environmental accounting. The QHSE manager approached first an academic colleague of mine, who was employed at an institute in the same faculty specialized in environmental and sustainable management. Given my interest in the area, it was then proposed to link a part of the dissertation to the collaboration project that would suit the support and feedback expected by DeltaChem. Thus, the case company initiated the research collaboration with a rather clear problem-solving orientation. It was nevertheless agreed that the field inquiry would have allowed the collection of data for academic purposes within a Ph.D. project. In carrying out the fieldwork, I was allowed as academic researcher to follow the implementation of a series of organizational initiatives carried out in DeltaChem regarding environmental management and environmental accounting. As a result, the term *modest intervention* (Jonsson, 1999:9-10) describes the research method followed in this case fairly well, given that:

> *"…the researcher assumes a role which does not lead to restrictions on the group polarisation process which may inhibit learning…The modesty of the intervention lies in the fact that the [Kolb] cycle is under the control of organisational members. This does not preclude the researcher from making suggestions or presenting counter arguments".*

Modest intervention seeks to focus attention on a problem of the actor's choice and help get first action started. This can be achieved by acting as a *conversation partner* (Jonsson, 1999:15). Likewise, an alternative term that can be applied for this study refers to the researcher as a *facilitator,* where (Scapens, 2004:264):

> *"…the researcher is closely involved in the case site, explicitly raising issues, giving advice and opening up options for the subjects of the research to evaluate. However, the researcher does not provide solutions, rather he/she enables the subjects of the research to recognise the nature of their problems and helps them find their own solutions".*

To complete the definitions available from research methodology literature, the role of the researcher in this study was nearer to a *clinical field study* according to the approach of qualitative inquiry suggested by Schein (1987:24):

> *"Clinicians enter an organization or any other human system only if they are requested to do so by someone in the organization or someone acting on the organization's behalf seeking some kind of help. In other words, the initiative in the clinical model is always with the client, even if the person who ultimately ends up in the clinical role has manipulated the situation so that someone in the organization will ask for help. …Clinicians are, by definition, highly visible since they have been asked to come into the organization, though the official reasons given for the entry of consultants and other kinds of helpers may be different from the actual reasons"*.

Recently, a number of case studies have been conducted following a similar approach in management accounting (e.g. de Haas and Kleingeld, 1999; de Haas and Algera, 2002; Kasurinen, 2002), which resembles the action research method advocated by Kaplan (1998) to revitalise research in the field. Action research involves planned intervention by a researcher into some naturally occurring events. Its twin goals are theoretical development and the provision of assistance to help solve a practical problem. The action researcher with theoretical ideas and practical experience may help clients make more sense of their practical knowledge and specific experience. Such an approach provides the opportunity for experimentation in natural contexts and gives the researcher inside knowledge that is otherwise unobtainable. With reference to the field of social and environmental accounting, Adams (2002:246) made a plea for more active involvement of academic researchers:

> *"If improvements in the extensiveness, quality, quantity and comprehensiveness of (environmental) reporting are to be achieved, then perhaps academic researchers should be engaging more with the companies that do it in order to gain a better understanding of their internal processes and attitudes to communicating this type of information and how they influence reporting"*.

A close examination of the case company was believed to be particularly revealing of current developments in the area of environmental management and environmental accounting. In fact, the reputation of DeltaChem in terms of its proactive engagement in environmental management was well known as one of the highest in its sector. This had been documented in popular press and in the parent company's website. A single, in-depth case study was therefore a reasonable choice because DeltaChem provided the opportunity to uncover the theoretical constructs that were previously modelled. In this respect, the research site was *a priori* considered a *representative* or typical case (Yin, 2003). Miles and Huberman (1994) observe that random sampling usually is an inefficient approach to qualitative research, particularly when the research is theory-driven. The peculiarities encountered in DeltaChem as the case unfolded will be specified in the limitations section of this chapter.

The case was constructed using a variety of evidential sources. These included: semi-structured interviews; documentary information like budget reports, manuals, procedures; internal memoranda and presentations concerning the on-going initiatives about environmental accounting; newsletters and publicly available information on the company's mission and activities, particularly in the field of environmental management and sustainability; press releases and media reporting about issues sensitive to the theoretical model; technical documents prepared by the industry federation (EuroChlor) that represents DeltaChem at European level[1]. All sources of evidence were reviewed and analyzed together, so that the case study's findings were based on the convergence of information from different sources. The use of multiple sources of evidence enables to crosscheck findings (triangulation), making conclusions more reliable and convincing (Yin, 2003). In order to provide a representation of a mass of complex textual material, I have necessarily simplified aspects of the case organization and distilled the main issues relating to the research objectives of the dissertation.

Several informal conversations were held with the QHSE manager who acted as main referent during the whole period of investigation. At the same time, I was granted access to other informants, belonging to the management team at the BU-level or to the line management at the operational level. In view of that, the case can be classified as an *embedded single case study* (Yin, 2003) as it reflects the analysis of one company at different units (i.e. headquarter and plants) of analysis. I was also allowed to attend internal meetings or presentations that were inherent to the implementation of the revised environmental performance measurement system. Altogether, approximately 90 hours were spent on interviewing, discussing and attending meetings in the case company during the empirical part of the study. Table 6.1 summarizes the activities performed during the period of investigation.

Table 6.1 – Summary of field study activities

Date	**Location**	**Activity/Theme**	**Duration**
October 23, 2001	University	Preliminary meeting	2 hours
November 9, 2001	University	Preliminary meeting	2 hours
January 2002	University	Set-up research project	2 hours
March-April 2002	University	Set-up research project	10 hours
April 3, 2002	DeltaChem headquarter	Presentation of research project	3 hours
May 3, 2002	DeltaChem headquarter	Data collection	1 hour
May 2, 2002	Corporate headquarter	Data collection	1 hour
June 14, 2002	DeltaChem Plant 1	Data collection	4 hours
June 20, 2002	DeltaChem headquarter	Session on risk management	3 hours
July 8, 2002	DeltaChem headquarter	Preparation of internal manual	1 hour
July 19, 2002	DeltaChem headquarter	Preparation of internal manual	2 hours
August 14-15, 2002	DeltaChem Plants 2 and 3	Data collection	10 hours
September 20, 2002	DeltaChem headquarter	Preparation of internal manual	2 hours
September 25, 2002	Conference venue	Presentation of research project	3 hours
October 8, 2002	University	Evaluation of research project	2 hours
October 29, 2002	DeltaChem headquarter	Data collection	1 hour
October 30, 2002	DeltaChem headquarter	Preparation of internal manual	4 hours
November 25, 2002	DeltaChem headquarter	Design EMIS	1 hour
November 27, 2002	DeltaChem Plant 1	Data collection	4 hours
December 16, 2002	DeltaChem Plant 4	Data collection	4 hours
December 17, 2002	DeltaChem headquarter	Assessment of research project	2 hours
January 16, 2003	Conference venue	Session on risk management	3 hours
January 21, 2003	DeltaChem headquarter	Design EMIS	2 hours
February 12, 2003	DeltaChem headquarter	Design EMIS	2 hours
May 5, 2003	DeltaChem headquarter	Design EMIS	2 hours
July 15, 2003	DeltaChem headquarter	Design EMIS	2 hours
August 11, 2003	DeltaChem Plant 1	Data collection	2 hours
September 29, 2003	DeltaChem headquarter	Data collection	3 hours
December 2, 2003	DeltaChem headquarter	Evaluation of research project	2 hours
July 19, 2004	DeltaChem headquarter	Update about developments	2 hours
December 23, 2004	DeltaChem headquarter	Update about developments	3 hours

6.3 Case setting

This section is structured as follows. Section 6.3.1 illustrates the case company background, with a focus on product and technology characteristics of the company investigated. Section 6.3.2 describes the main aspects concerning the performance measurement and control systems. In Section 6.3.3 the environmental management systems implemented at DeltaChem are described. Recent initiatives within the company in the area of environmental management are described, in particular with reference to the change in environmental performance measurement system that will be specifically addressed in Section 6.3.4.

6.3.1 Products, technology and business strategy

DeltaChem is a major producer of chlorine and alkali products in the European market. Chlorine has diverse applications across many sectors. Chlorine and caustic soda are used as input in approximately 55% of the production of the chemical industry worldwide. One-third of products made using chlorine contains no chlorine, but depends on it for synthesis. This alkali is used in a wide range of applications, such as manufacture of soaps, detergents, textiles, vegetable oils, pulp and paper, aluminium and glass. It must be emphasized that the commercialisation of chlorine is heavily regulated because of the risks involved in the production, shipment and final use of this feedstock. In fact, chlorine is a hazardous product to man and animals when released. There is a general concern about the risk posed by chlor-alkali chemicals to human health and the environment that makes production, transportation, use and disposal of these substances a sensitive matter of public interest. The market of these chemical products is therefore restricted to a limited number of operators and industrial consumers.

As far as technology and production processes are involved, chlorine is produced by electrolysis[2] of common salt. In addition to chlorine, which is produced in gaseous form before being liquefied, electrolysis also produces caustic soda and hydrogen. A major part of chlorine's value lies in its co-product caustic soda. Three different electrolysis processes are currently available to produce chlor-alkali products. First, the *mercury* cell electrolysis, which was the first technology to be developed on an industrial scale and was principally developed in Europe. Mercury cells consume large quantities of energy and require the application of appropriate measures to maintain mercury losses at extremely low levels given its extremely high toxicity for humans and the natural environment[3]. Second, *diaphragm* cell electrolysis uses an asbestos diaphragm deposited on an iron grid cathode to prevent the chlorine and caustic soda (which are formed at the anode and cathode respectively) from re-mixing. This process requires less energy than the mercury cell process. However, in order to obtain a saleable caustic soda solution, it is necessary to evaporate the water and precipitate the salt. This concentration process is extremely costly both in terms of capital investment and energy and does not produce caustic soda of sufficient purity for certain applications. Third, *membrane* cell electrolysis is divided into two compartments by a membrane acting as an ion exchanger. The anodic compartment is filled with saturated sodium chloride brine and the cathode compartment with pure water. The membrane cell process has three advantages: the energy consumption is similar to that of diaphragm cells; it allows production of very pure caustic soda; and it produces negligible environmental impacts.

Mercury cell capacity in Western Europe has gradually diminished over the last two decades and now represents just below 50% of installed capacity. Mercury emissions will continue to decline as plants change to membrane cell technology. The European chlorine industry has already committed to abandoning the mercury process for all new capacity and proposed in 1999 a six-point voluntary agreement that would result in the closure or conversion of the existing mercury cell plants by no later than 2020. The key question for the chlor-alkali industry is how the technological conversion may best be managed in a sustainable manner – meeting its three requirements of environmental, social and economic criteria. This conversion is a major challenge for the industry with socio-economic implications requiring huge capital investments. Moreover, by the time the plants close, the amount of pure mercury that will become available – now down to about 11,000 tonnes in Western Europe – needs to be decommissioned in a responsible manner.

DeltaChem operates 7 production facilities in Europe. Because chlorine is a hazardous and reactive chemical, production plants have to meet stringent safety, health and environmental standards. The transportation of chlorine is heavily regulated by international and national safety rules. The company ensures a dedicated transport of the product shipped to the final user. By far the greater part of chlorine output is delivered to customers by pipeline, followed by rail using specially approved rail-tank-cars.[4] In its business policy, DeltaChem publicly commits itself to keep the likelihood of incidents to a minimum and aims to reduce chlorine transportation by train in the longer term. However, at the moment the research collaboration with DeltaChem started, the national authorities were looking for a solution to eliminate the risk of hazardous products dispersion in case of train accident. Following extensive consultation between governmental agencies and DeltaChem, a covenant was eventually reached on July 2002. The agreement settled that regular transportation would cease by 2006, allowing a maximum of 10,000 tons to be transported per year on an occasional basis after that date. The implications of this agreement were relevant for DeltaChem for different reasons. The most direct effect was that two plants were planned to shut down at the end of 2005, with an expected downsizing amounting to a net loss of 150 employees. By contrast, the capacity of one membrane plant location is expanded, while another new chlorine plant is built on another location. This decision was taken to ensure the stop of regular transport and therefore minimizing risk of transport from 2006. The risk reduction is obtained by transporting chlorine through pipelines. It should be emphasized that environmental aspects played a decisive role in the settlement of the negotiation.

With regard to market characteristics, chlor-alkali products are commodities, whose demand is strictly dependent upon the industrial customers operating in the chemical sector. Being production completely inter-related with downstream businesses, the uncertainty surrounding the chlor-alkali industry is largely a function of external customers' demand and indirectly of general economic conditions. Recall as well that chlorine and its by-product caustic soda are obtained in fixed proportions and depend on the capacity installed. Given the capacity constraints, DeltaChem's strategy focuses on efficiency improvement and control/reduction of costs. It therefore resembles the strategic mission typology *hold* proposed by Gupta and Govindarajan (1984), which is distinctive of mature industries with high entry barriers. It appears also that DeltaChem's strategic position is classifiable as *cost leadership* oriented following Porter (1980), being characterized with a focus on low price, high market share, standardized products and economies of scale (cf. Kald *et al.*, 2000). As a consequence, strategic and operational decisions taken by DeltaChem management seem primarily driven by volume-related concerns, measured by saturation of capacity, as relevant indicators of plant performance. Similarly to other competitors in the chemical sector, DeltaChem's marketing and IT functions are massively investing in e-business solutions aiming at installing procurement channels with customers via Enterprise Resource Planning (ERP) systems. The investments in IT are expected to improve functionality for customers using the company web-site by ensuring on-line ordering, improved order status and efficient handling of complaints. Finally, the Research and Development (R&D) activities of the Business Unit are focused on plant support, cost reduction projects and improvements of the technological process and safety. Sustainability is a guiding principle in the definition of R&D strategy to mitigate the environmental impacts of DeltaChem operations (e.g. improvement of energy efficiency, phase out of hazardous materials and closed loop incineration).

To sum up this section, DeltaChem operates in a mature niche of the chemical industry in which the nature of substances processed and transported potentially expose human health and the natural environment to high risks of toxicity. The environmental sensitivity or environmental exposure associated to DeltaChem represents a relevant contingency factor that affects structural aspects (technological processes and organizational design) and management systems. The next section provides an overview of the main characteristics of the Business Unit with regards to its organizational design and management control systems.

6.3.2 Organizational design and management control systems

DeltaChem is organized on a functional basis, comprising different sub-Business Units (sBU's). The management layer operating at the BU level is functionally organized with a management team consisting of a general manager and four managers responsible for

Human Resource Management, Quality Health & Safety and Environment (QHSE) management, Control and Communication respectively.

A specific organizational feature in DeltaChem is the presence of multi-plants locations. In the same production site, DeltaChem shares different services and utilities with other plants hierarchically controlled by other business units belonging to the same parent company. Among them, the Human Resources function and the QHSE function serve the various plants from a centralized unit located in the site. Decisions concerning production, marketing and sales are delegated to sBU's managers given their *specific knowledge*[5] about operations and logistics. The production process at the plant level is continuously monitored by means of semi-automatic control devices that track effluent volumes and critical parameters along the different process lines. Strict adherence to manuals and procedures and personnel training represent the main types of organizational control mechanisms in place at the operational level. Line managers intervene to solve out-of-control situations with a management by exception approach. Internal audits are periodically carried out within DeltaChem by mixed teams of auditors formed at the corporate level. Assurance procedures are formally enforced to ensure that operational manuals are strictly followed and measures for improvement are continuously taken using state-of-the-art technology.

At the operational level, a monthly report is issued containing detailed production data and several indicators concerning efficiency and productivity levels. At the BU level, the main internal financial reporting is issued on a monthly basis and includes variances against the budget and Economic Value Added (EVA). Other financial indicators include Return On Sales and Return On Investment. Management reviews and meetings are periodically held to control matters concerning financial and operational results. A quarterly rolling forecast, coupled with a three-year strategic plan, is issued for each area of the business. Plants and BU accounting departments use an integrated ERP system recently implemented.

The Human Resource (HR) Policy of DeltaChem introduced at the end of 2001 emphasizes the decentralized structure of the organization. One of the most relevant features of the new policy refers to the introduction of a revised incentive scheme in place since January 2002. Up to 2001, the incentive scheme implemented by the parent company was linked to the financial performance at the country level, without making any distinction among divisions. By the end of the 1990s, HR managers encouraged a change of performance evaluation and reward system as they realized an increased dissatisfaction about the perceived lack of controllability towards corporate performance at the country level. The need for a more tailored incentive system was also explained by the extreme diversity among different businesses operating in the divisionalized parent corporation. In its current design, the reward system attempted to cope with these drawbacks by introducing a gainsharing mechanism that is tailored to each division.[6]

At BU level, the salary package contains a variable compensation part that amounts a maximum of 11% of the annual salary computed as follows: 6% was based on EVA calculated at the corporate level, while 5% referred to individual personal targets. The choice of performance type and level of organizational/individual targets for the functional managers in DeltaChem occurs after a negotiation process with the general manager. The time horizon for the periodic evaluation is one year. The general manager relies annually upon a subjective performance evaluation of the functional managers' performance. It is important to emphasize that, at the BU level, there are formal quantitative targets attached to specific objectives concerning environmental performance.

At plant level, a gainsharing reward system was introduced in a number of plants since January 2002. A variable pay scheme applies to senior management functions that could amount to a maximum of 15% of their flat salary: 5% of the bonus referred to a set of non-financial performance measures, while 10% was computed on the basis of EVA results at BU level. The metrics included in the "scorecard" at the plant level were object of negotiation among workers. Targets were set for the year period and the monthly performance publicly communicated at the end of the month. The allocation of the bonus was in proportion to the weights allocated for each metric.

Table 6.2 – Example of performance measures categories in the 2002 gainsharing scorecard in one plant

▪ Safety performance at the site level
▪ Safety performance at the plant level
▪ Productivity levels
▪ Mercury emissions
▪ Ideas and suggestions for improvement

For instance, the gainsharing scheme in place in one plant is described in Table 6.2. It was noticeable that, within the same site, multiple plants designed different "scorecards" on the basis of the key parameters that were considered as crucial in affecting their particular business and production technology.

During the research collaboration, the gainsharing scheme was object of controversy – among other issues – between DeltaChem and the Trade Unions. The controversy confirms recent empirical evidence illustrating that the reactions following the practical implementation of EVA and other performance management models are often more problematic than expected (cf. Riceman, Cahan and Lal, 2002). For practical implications that the labour agreements exerted to the research project refer to the limitations presented in Section 6.6.

To summarize, the main organizational features of DeltaChem emphasize a decentralized structure that allocates decision rights to lower level operational management. At the same time, internal control and accountability systems are in place to guard decentralization and protect the company from excessive agency costs. Consistently with the theoretical notion of the "organizational architecture" (Brickley *et al.*, 2001; Zimmerman, 2003) mentioned in Section 2.3.2, performance measurement and reward system moved away from reliance on traditional accounting-based measures of performance and comprise instead measures that emphasize a) the close monitoring of operating efficiency in a decentralized structure by relying upon non-financial information; and b) the creation of value through the computation of "innovative" performance management systems (i.e. balanced scorecard coupled with a gainsharing mechanism, Economic Value Added). In the subsequent section, I will focus on the characteristics of the company's environmental management system.

6.3.3 Environmental strategy and environmental management system

The parent company of DeltaChem has established a clear policy with regards to environment, health & safety, and product stewardship issues. The Board of Directors at the corporate level actively supports the guiding principles contained in the Business Charter for Sustainable Development (guidelines proposed by the International Chamber of Commerce). In particular, a member of the Board is in charge of HSE aspects in the organization. A corporate director of HSE and Corporate Social Responsibility was appointed in late 2003 to coordinate internationally the activities in these areas. Given the diversified structure of the parent company, responsibilities with regards to HSE management are delegated to functional managers employed at the group, BUs and sBUs level as a staff member. The corporate HSE function maintains a coordinating role among the various HSE lower-level departments. A series of corporate directives are issued and driven down in the organization. These directives deal with management systems, performance measurement, internal communication and reporting, internal audits and product stewardship policy. The corporate principles are publicly available from the Internet website and are part of the annual corporate HSE report.

At the operational level, HSE management is a line responsibility and environmental performance is managed with regards to all aspects of DeltaChem's business activities. Concerning plants' design and construction, baseline technical, environmental and health data are collected before the development of any new operation, facility or major operation. Plants are designed using state-of-the-art technology that tends to minimise or eliminate emissions, discharges, impacts on biodiversity and other environmental impacts. Project management systems and procedures addressing technical integrity and HSE accountability are documented by dedicated investment appraisals that formally include HSE requirements and reviews (the, so-called, *Investment Manual*). With regards to operations and maintenance, applicable regulatory requirements are met or exceeded and operational integrity is maintained by use of clearly defined and documented operational, maintenance and inspection systems. Key operating parameters are established and routinely monitored. HSE impacts associated with waste, emissions, noise, energy use are continuously scrutinized and minimised whenever possible. In addition, changes in legal and regulatory requirements, technical codes and knowledge over HSE effects are periodically tracked. DeltaChem management tends to include these early signals' to initiate appropriate changes. In this sector, thus, the possibilities to improve the HSE performance are heavily constrained by the production technology employed. Improvements of the environmental impact of operations can be achieved by a combination of three actions: 1) technology substitution, by introducing more environmentally friendly production processes; 2) increased process efficiency, by reducing the amount of energy consumed; and 3) continuous housekeeping and frequent maintenance, by appropriate training of the operation personnel. In order to influence and motivate behaviour at the operational level, the incentive scheme described in the previous section contains some indicators that are environmental-related. Interestingly, one of the problems emerging from the on-going dispute between management and trade unions about the gainsharing mechanism pointed at the lack of controllability perceived by the employees with respect to some performance measures. In a note accompanying the negotiations, it was evident that the scheme created dissatisfaction in terms of low controllability and, ultimately, reduced fairness and motivation toward the incentive (source: internal memo available from the corporate web-site).

In order to practically manage HSE performance and strive for the sustainable objectives highlighted in the corporate policy, DeltaChem is engaged in a series of voluntary internal initiatives. The business policy of the parent company emphasizes the relevance of international standards for HSE management systems. In adherence with the policy, 5 of the DeltaChem plants obtained an ISO 14001 certification. The plants are also certified ISO 9002 (quality management system) and 3 of them obtained the OSHA 18001 certification (health & safety management system). The Responsible Care programme represents a specific voluntary initiative of the chemical industry, committing members to continuous improvement in all aspects of HSE performance. DeltaChem is committed as other Responsible Care companies to use integrated management systems in the coordination and control of environmental, health & safety and security performance of its facilities (cf. Responsible Care, 2004). Other company initiatives are undertaken to respond to regulatory schemes enforced on HSE-related activities by public authorities. DeltaChem is also voluntary involved in national and local programmes aiming at reducing the environmental impacts of its operations and increasing the efficient use of energy. For example, a recent initiative focuses on reusing the hydrogen produced during electrolysis. The installation of recovery units using fuel cell technology is under study in collaboration with an energy company to utilize the hydrogen that is alternatively burnt.

DeltaChem control mechanisms rely heavily on HSE performance indicators because they are frequently used to control the operational process. As described in Section 6.3.2, some indicators enter in the bonus system at the operational level. With regards to management control, there is not a formal, formula-based contract that includes HSE metrics at the BU level. At this level, managers are subjectively evaluated by taking into account the overall HSE performance. Targets achievements in this area are evaluated subjectively. Participation in target setting occurs at the beginning of the year in an individual meeting between the BU manager and staff/line management.

At the outset of the investigation, DeltaChem was engaged in a change program labelled *"HSE Excellence"*, aiming at improving existing environmental management systems and better integrating them into daily operations and BU strategy. The following excerpt from an internal presentation prepared by the QHSE manager summarized the core principle or "vision" behind this program:

> *"HSE Excellence beyond current conception. A chlor-alkali business that by its strategy and its communication, its control, monitoring and reporting is accepted by society".*

The QHSE manager believed that the achievement of the *"HSE Excellence"* required the establishment of three "licenses" at the different levels of the organization. Drawing from recent catchwords introduced in the popular business literature, he suggested a *"license to operate"* at the plant's level, a *"license to sell"* at the business unit level and a *"license to exist"* at the corporate level. As noted by Gunningham, Kagan and Thornton (2003:36) the concept of a organizational "license" captures the complexity of the relationship between the company and key stakeholders. A company's failure to meet social expectations concerning environmental performance can impair the firm's reputation, adversely affect personnel recruiting, and trigger demand for more stringent and intrusive regulatory controls.

The program was run by DeltaChem independently from other divisional or corporate initiatives, as there was no formal obligation that was imposed from the corporate level to other business units of the same corporation. The general manager confirmed this decentralized approach to formulate environmental strategy:

> *"The QHSE strategy appears more driven by our own business unit than the corporate strategy. There is obviously a common framework that plays a role in shaping the strategy in all business units. We also have to comply with environmental laws. However, the QHSE strategic focus is mainly driven by DeltaChem's own strategy".*

The management at the BU level showed relentless commitment to support the program. In particular, the newly appointed QHSE manager functioned as a "program champion" within the organization. With a strong technical background and relatively long past experience in similar positions at different organizational levels, the manager essentially played a senior management role in designing and executing the change program. At the outset of the field study, he coordinated three complementary projects that were established with the active involvement of personnel both at the business unit and at the plant level. The three initiatives are briefly discussed next.

The first change initiative was labelled "*management systems*" and addressed the need of increased harmonization among management systems in different but contiguous areas (quality, health & safety and environment). In particular, the project aimed to synchronize activities carried out for internal control through operational audits. More coordination was also encouraged across plants in order to enhance strategic planning at the business unit level. An initial inventory of current systems, procedures and processes in place provided a preliminary understanding of the initiatives required to augment their alignment. The successive stage consisted in ensuring further uniformity to the systems. Another initiative running in parallel to this one consists of a corporate program that specifically concentrated on "*Enterprise Risk Management*" as innovative approach. The program was finalized to enhance the capabilities of the different business units in terms of recognition, management and prevention of business, operational and societal risks. As connections were established between this initiative and the one concerning the environmental accounting project, some details about the risk management project are provided in the next section.

The second project dealt with DeltaChem's "*substance policy*". In a nutshell, it consisted in the preparation of a comprehensive information infrastructure to be available for customers and regulatory requirements about products' characteristics. The concept of Product Stewardship was the cornerstone of this initiative. The purpose of Product Stewardship is to control and improve the health, safety and environmental aspects of a product during its complete life cycle in an economic responsible manner by way of a continual improvement process. Product Stewardship covers all stages of a product's lifecycle - initial concept, design, research and development, the sourcing of raw materials, manufacture, storage, distribution, applications, reasonably foreseeable uses, recycling and disposal. It requires managers, employees, contractors, customers and all the parties involved in the supply chain to cooperate in following safe and environmentally sound practices. The first step was to execute an inventory of substances and products manufactured or handled in DeltaChem. The second step consisted in setting up a common policy that internally regulated processes and decisions concerning supply, production, shipping, use and final discharge of DeltaChem substances (so-called "from cradle to grave" approach).

Finally, the third initiative was called "*environmental accounting*" and focused at improving the environmental-related information available, as well as reporting aspects of HSE management within and outside DeltaChem. Similarly to the first two projects, the initial part of the initiative required an inventory of existing reporting procedures and documents used at the plant and BU level. The broad objective was to develop a new reporting procedure to ensure higher reliability of data collection and disclosure. The project involved not only technical personnel but also personnel from the accounting and control departments. After having refined the "information infrastructure" available, the second objective was to create a more useful control system which would keep track of Key Performance Indicators (KPI's) in the HSE area. On the basis of the KPI's, an adjustment of the performance measurement and incentive system was eventually expected to ensure closer alignment between operations and business unit strategy.

The next section focuses on the latter initiative observed in DeltaChem given my closer involvement in the implementation of the revised environmental performance measurement system. I will describe the course of events referring to the so-called "environmental accounting project" set-up in DeltaChem. It is argued that the initiative represents a case of (management) accounting change, where the change emphasis specifically refers to a sub-system of performance measurement focused on environmental-related information. In presenting and discussing the initiative, I will rely upon the distinction made by Dawson (1994) who indicated three conceptual phases to study processual change in organizations: (1) conception of a need of change, (2) process of organisational transition and (3) operation of new work practices and procedures. The case study concentrates particularly on the first two phases because the effects related to the project mainly occurred beyond the temporal limit delimited by the research collaboration.

6.3.4 The environmental accounting project

The motivation of this initiative can be attributed to the recognition in 2001 that the available performance measurement and reporting system was not appropriately aligned with the quality of the information that the management at the business unit level perceived as useful for decision-making and control. An upgrade of contents and process of performance measurement systems was considered necessary since only a part of HSE information generated at the plant level was systematically communicated at the BU level for planning and control purposes. The general manager confirmed the rationale of the environmental accounting project as follows:

> "*HSE Excellence is an important element in this sector and in our organization. With a QHSE accounting system in place our objective is to get the right information available at each level of the organization, so that we can act on both short- and long-term environmental performance coherently with our environmental strategy*".

In fact, a great amount of *ad hoc* reporting and analysis regarding HSE performance was located in different plants of DeltaChem. It appeared that the responsibility and the ownership to collect and aggregate data at the local level differed from plant to plant. The information generation and collation process was not optimally structured because there was not a common procedure that applied uniformly to the plants accountable to DeltaChem. In particular, reporting schedules (so-called *reporting agenda*) and reporting recipients (e.g. environmental control agencies, local residents and environmental organizations) differed considerably across plants. A key aspect was that technical functions fulfilled the collection and reporting of HSE data in the different plants. On the contrary, the involvement of the accounting department at the site was very limited. In some cases, a specific person was appointed to provide HSE data. In other cases, however, the responsibility was not clearly assigned. There was a fear that, in absence of a well-documented and uniform system of performance measurement, a loss of knowledge would have occurred in case the responsible individuals had left the company. On this matter, an illustrative example in one multi-plant location was given referring to an employee who had been for years the designer and the "owner" of a detailed HSE performance measurement system (he was friendly nicknamed as the "environmental accountant"). His retirement generated some problems due to the lack of expertise of other employees in the area, but also to the absence of written procedures about the reporting system previously devised.

An additional explanation for a more structured performance measurement system was related to the corporate HSE reporting requirements that applied uniformly in all the operating business units of the parent company. In 2001, a set of five performance indicators were chosen by the corporate Board of Directors to gauge HSE performance across the different business units. Corporate objectives were set for 2005 as described in Table 6.3.

Table 6.3 – Corporate Health & Safety and Environment (HSE) objectives for 2001–2005

Corporate HSE parameters	**2001 actual**	**2005 target**
Frequency Rate Lost Time Injuries per 1 million hours worked	3.6	2.5
Total Illness Absence Rate	2.7	3.5
Chemical Oxygen Demand of discharge to surface water (tons)	4,000	3,000
Volatile Organic Compounds (VOC) emission to air (tons)	6,300	4,000
Non-reusable waste (tons)	126,000	115,000

The data provided by each business unit were consolidated by the HSE function located at the corporate headquarter. After consolidation, the data were therefore included in the annual HSE report. The decision to focus on five parameters was explained by a member of the Board in charge of HSE affairs as follows:

> *"Under the previous system, we set our business units targets and we more or less collected data from the different sites and published some of the results. It was really a question of collecting the figures and publishing them rather than managing them. Now we have chosen to consolidate figures relating to five specific parameters on a corporate level. The business units concentrate on putting together their own plans for meeting these targets, reducing levels at their respective sites and working towards improvements. In this way, we also get a clear overall picture of how the three groups are doing".*

The Board member further commented:

> *"… We are publishing less data, but it does not mean that we are doing less. In fact, we are doing more. We can now focus on each site and work on improving local performance. It is our aim to bring all the sites to a similar level by adopting the highest standards. If you build a plant in Asia for example, the authorities may have more relaxed regulations than in Europe. However, we will take the strict regulations and apply them company-wide. This means that we won't try to save money by taking short-cuts. We will adopt a standard to try to make us 'best in class'".*

A striking aspect concerning the five parameters' plan was that for some business units the entire set of performance indicators was not applicable. For example, the metric regarding the level of *Chemical Oxygen Demand* (an outcome measure of the environmental burden to surface water) was not pertinent within DeltaChem because this aspect is of negligible relevance in its production facilities. Nevertheless, all operating units were required to report on these five indicators to ensure homogeneity of data and benchmarking over time against the targeted levels for 2005. This aspect emphasizes the relevance of having simple but comparable performance measures that allow internal benchmarking among different business units.

Since the inception of the HSE targets, the general managers of each Business Unit were held responsible of the accuracy and reliability of the data to be consolidated at corporate level. It appeared from conversations with DeltaChem's management that the provision of the set of indicators did not really represent a burden in terms of availability of this type of information. A much wider and complex amount of performance metrics was actually tracked, monitored and reported within each multi-plant location for reporting entities others than the corporate HSE department As a result, the provision of the five parameters was considered as a mere by-product of the existing internal performance measurement system. Nonetheless, the focus on five dimension of HSE performance drove the attention of the management towards existing drawbacks in the performance measurement and reporting systems. In the long run, it was expected that a wider amount of data would be requested for the corporate annual report and for other reporting requirements from external stakeholders.[7] DeltaChem's general manager explained about the increased pressure on internal and external accountability:

> *"At each level the company is confronted with QHSE-related issues. If an incident occurs at the site, information needs to be passed on to the upper level to understand its causes. …Of course a company like ours needs to have the right performance measures in place. We are confronted with data by all sides, from society, from EuroChlor, but also from our clients. So, you have to create a set of data. If you don't do it, you are confronted with the problem sooner or later".*

He further added that:

> *"It's an enormous administrative work in a decentralized organization like ours to aggregate the right information. It is already difficult for me to organize the work in a business unit. The managers at the corporate level face even a more complicated task, because they need to gather information from several business units".*

Another driver of the environmental accounting project could be traced to the *risk management project* that was initiated as a corporate initiative in 2001. The initiative aimed to foster awareness of different dimensions of business risks at different levels of the corporation. Among them, HSE risks were considered as central for business units like DeltaChem that operate in industries where environmental, health and safety aspects of processes and products are highly critical for operations and logistics. Under the coordination of an external consultancy firm, risk management procedures were devised by a newly temporary created risk management function located at the corporate headquarter. These procedures were developed in conformity to existing internal control and assurance systems. To support the implementation of the project, a specific report addressing HSE and other enterprise risks was expected from each business unit, containing perceived likelihood of risks, the assessed risk impact and the effectiveness of control measures to mitigate them. On the basis of these additional requirements, a more accurate and standardized performance measurement system for HSE performance acquired priority in DeltaChem.

Taken together, the improved environmental accounting system was expected to deliver more informative data about DeltaChem operations on health, safety and natural environment. The "information infrastructure" (Galbraith, 1973) that was supposed to deliver reliable and relevant data regarding HSE performance was perceived as being not coherently designed. The actual collection and reporting of information was recognized as not completely adequate to ensure horizontal and vertical lines of communication in DeltaChem. Accountability towards external stakeholders was perceived as a relevant driver for more accurate and timely information, though the driving concern of the management was particularly focused on internal managerial control aspects. The current weaknesses of the performance measurement system were of particular apprehension for the QHSE manager who had been recently promoted from another position of the same corporation. He recognized that an improvement was needed with regards to the contents of the information to *"steer the organization towards HSE Excellence"*. He was particularly aware of the dispersed expertise about HSE reporting and the necessity to converge towards an environmental accounting system that would add consistency to DeltaChem internal and external reporting practices. In his previous position, he was already involved in similar initiatives and he had developed sufficient know-how with respect to HSE performance measurement and reporting to initiate the change in current performance measurement systems. About the need for a revised QHSE accounting systems, the QHSE manager commented:

> *"For all the aspects that are object of the QHSE strategy, information is needed. Information in most cases is available but it needs to be organized in such a way that can be validated and upon which management can take decisions. This has not happened in the past since QHSE-related information was a locally oriented issue. More and more it becomes a business-oriented issue. …The formulation of strategy represents the starting point. QHSE accounting allows the monitoring of strategy implementation. As such, this system should not serve only the purposes of the QHSE function, but also as generic internal control mechanism. The same requirements of the financial accounting system should apply to the QHSE accounting system".*

By the end of 2001, the QHSE manager initially engaged in an internal discussion in order to cope with the limitations of the performance measurement system. In consultation with the general manager of DeltaChem, in January 2002 the preliminary ideas on how to execute the environmental accounting project crystallized around two objectives. The first goal was to inventory available methods and measures (labelled as *"HSE parameters"*) from functional units responsible at the operational level. The second goal aimed at the preparation of a procedure that would ensure uniformity in the data generation and reporting mechanisms of HSE performance. At this stage, my role as external researcher within the project was to provide support to the QHSE manager in designing the project and conducting the initial analysis of available systems and procedures. Table 6.4 summarizes the main course of events as they unfolded during the period of investigation.

My formal involvement in the environmental accounting project was internally disclosed at the outset of the initiative. During the initial kick-off meeting organized at DeltaChem headquarters, the QHSE manager illustrated the program *"HSE Excellence"* and specifically introduced the main objectives associated with the environmental accounting project. I completed the presentation by addressing broad topics related to performance measurement and management control together with my supervisor. It is important to emphasize that the general manager clearly announced his full commitment to the program as a key component of the business strategy of DeltaChem. Line and business unit management attended the meeting. During the discussion following the presentation, a couple of participants expressed their concern about possible duplication of goals with the concurrent project over risk management that was at the time in its starting phase. The QHSE manager and the general manager ensured them about the attempt to integrate the efforts and the objectives of the environmental accounting project with the risk management project. This episode epitomized a typical impediment for organizational change categorized as *credibility anxiety* (Gabris, 1986 cited in Waggoner, Neely and Kennerley, 1999), a condition where a multitude of management techniques are "piled on top" of one another and organizational members fear that the overload of techniques may not provide beneficial and useful effects.

Table 6.4 – Milestones of the "environmental accounting project"

Timeframe	**Activities**
December 2001 – March 2002	Set-up of research collaboration between university and DeltaChem
April 2002	Presentation of the research collaboration to management team
May – September 2002	Round of interviews, collection of documents, collaboration with management team
September 2002	Set-up of internal interdisciplinary working group on Quality, Health & Safety and Environmental Accounting: appointment of an internal project coordinator
September 2002 – March 2003	Inventory of existing performance measurement systems and preparation of a new procedure formalized in a manual for internal and external reporting
May 2003	Appointment of a new project coordinator
September 2003	Definition of operational targets (Key Performance Indicators) and reporting agenda for all reporting units in DeltaChem
January 2004	Introduction of selected Key Performance Indicators in financial reporting
Late 2004	Selection of software platform to support the new QHSE accounting procedure

In the first phase of the project, a team of employees selected from the various facilities was formed involving both technical and accounting personnel. The rationale behind the "environmental accounting task-force" was to integrate expertises both in the design and maintenance of the environmental accounting system. The team met for the first time in September 2002. Similarly to the kick-off meeting, a brief presentation was held by the researcher to introduce the participants about the role of management accounting and control in environmental management. The commitment to the project was emphasized by the presence of the BU controller. In his presentation, he underlined that the revised environmental accounting systems needed to be systematically integrated into existing accounting and reporting systems. Additionally, he proposed to include the environmental accounting system, once implemented, to the list of internal and external auditable systems. It is interesting to note that most participants expressed interest in the initiative, while at the same time making explicit their concern of excessive *process burden* since they were expected that the initiative would take them time away from their actual responsibilities.

In a subsequent phase, an internal consultant employed in a service unit of the corporate organization was appointed to coordinate the initial effort of organizing the first meetings, allocating tasks and providing feedback about project developments. The QHSE manager acted as a supervisor of the project and participated to each subsequent meeting.

At the outset of the project, a relevant portion of time was dedicated to the revision of the manual and procedure about HSE accounting. The rationale that was followed in the preparation of the first draft was based on the separation of duties between technical personnel and accounting & control personnel, consistently with the precepts of keeping a distinction between decision management and decision control (Fama and Jensen, 1983). The QHSE manager and the internal consultant recognized that the specific knowledge about the collection of HSE indicators should have remained in the hands of the “environmental guys” at the plant level. The knowledge of the production processes enabled the technical functions to collect (measure or calculate) QHSE parameters in an efficient way. In addition, they were better equipped to understand and control the measurement output. At the same time, however, it was agreed to attempt and call for the active involvement of the accountants in the internal reporting process for two reasons. Firstly, the accountants were considered as the experts in data collection and reporting of financial-related information. Likewise, it was expected that the accountants could adequately fulfill their bookkeeping/reporting role also with regards to non-financial information in the HSE area. Secondly, the accounting department was perceived as the owner of the accounting information system. Even if it was not the primary concern in this phase of the project, the issue related to the integration of the HSE accounting systems in the current accounting information system was foreseen as a key aspect of the project to be solved lately in the implementation phase. Consistently with these arguments, the manual attempted to design a procedure where in essence a double check of the HSE figures was expected at the plant level before the final reporting would occur to external stakeholders and the BU management. A series of meeting were held between the QHSE manager, the internal consultant and the researcher to prepare a draft regarding the environmental accounting procedure. The draft was then submitted to the attention of the mixed project team comprising both technical and control personnel. The refinement of the procedure required several corrections, specifically aiming at reducing margins of interpretation and a streamlined solution once implemented in practice. The logic and the sequence of activities proposed in the most recent version of the procedure can be illustrated in Table 6.5.

Table 6.5 – Elements underlying the procedure concerning measurement and reporting of HSE performance measures

	***Technical* (QHSE-related) function**	***Control* (Accounting-related) function**
Core activities	Data generation	Data reporting
Sequence of activities	Step 2: Data measurement Step 4: Validation	Step 1: Initiation Step 3: Ratification Step 5: Consolidation & Reporting
Input information	Definitions about measurement/calculation of QHSE performance indicators	Yearly reporting agenda
Output information	List of key performance indicators	Internal and external QHSE reports

The procedure conceives that the ownership of the HSE accounting system needs to be shared by two functions, the technical (QHSE-related) function *versus* the control (accounting-related) function. Five chronological steps can simplify the sequence of activities to be followed:

- Step 1 – *Initiation*: the control function prepares the request of data generation on the basis of the yearly reporting agenda at various organizational levels (plant, BU and corporate);
- Step 2 – *Data measurement*: the QHSE function collects or computes the set of parameters following the strict definitions contained in the procedure. The data are then transmitted to the control function;
- Step 3 – *Ratification*: the conformity of the data with the definitions is checked by the control function. A preliminary list of performance indicators is prepared;
- Step 4 – *Validation*: corrections are discussed by the technical functions at various organizational levels if needed. The validated list is transmitted to the control function;
- Step 5 – *Consolidation & Reporting*: the list of parameter is consolidated and tailored to the final recipient of the data. The data are subsequently reported a) internally at the plant, BU and corporate level and b) externally to DeltaChem stakeholders.

While participating at the preparatory meetings of the manual, it was evident from the discussions that the choice of the *measurement technology* and *reporting format* occupied a significant part of the project. It was interesting to notice that the definition of some HSE performance metrics left some space for subjectivity and interpretation. Additionally, the format under which certain performance measures were reported seemed to differ as a function of the final user of the measure. Particularly at the plant's level, the functions in charge of HSE data collection admitted their difficulty in reporting them to a variety of internal functions and external stakeholders. The difficulty aroused from the different levels of detail or *aggregation* of the performance measures. In order to ensure uniformity of definitions, it was essential to choose which of the several (international and national) guidelines available would have been followed to prepare the reporting manual. As a general course of action, three guidelines were eventually considered as most appropriate for DeltaChem. First, the Sustainability Reporting Guidelines proposed by the Global Reporting Initiative (GRI, 2002 and Section 2.2.2) was judged as the framework with the broadest applicability and highly recognition at international level. Second, a draft document about, so-called, “sustainable indicators” elaborated by the European chlorine association provided more specific guidelines for the industry in which DeltaChem operates. In a further phase of the project (January 2004), the European chlorine association ratified the list of sustainable indicators and detailed targets were specified for 2010 for all the industrial players in the same sector. As member of the federation, DeltaChem was actively committed to adhere to the reporting of the indicators and the respect of the targets. Third, examples of applications of more sophisticated performance measurement systems were subject of discussion during the preparatory meetings. Among them, for instance, measures of so-called *environmental burden* (EB) were seen as a more advanced methodology to measure environmental impacts particularly in the chemical sector (WRc, 2003). In fact, the reporting of simple annual tonnages of substances released from an individual industrial site, or from an industry sector, does not immediately convey useful information about the impact of such releases upon the environment. For each substance, there is a different a) *behavior* in the environment (e.g. the distribution of the released substance between air, water and soil; its tendency to degrade); b) *exposure* of affected populations, in the case of toxicity (e.g. the extent to which an organism takes up the substance from the different environmental media); and c) *potency* or inherent strength (e.g. toxicity; ability to absorb radiation and so contribute to global warming). The EB approach seeks to overcome, or at least to reduce, this difficulty by converting the tonnage of released substances into more meaningful measures of impact. In principle, EB measures may make allowance for all three of the factors noted before, or they may make allowance only for Potency, or for Potency and Behavior. Thus, for example, the EB measure “Global Warming Potential” takes into account a) the potency of different substances in terms of their tendency to absorb light of relevant wavelengths, and b) their behavior in the environment, in terms of how long the substance remains in the atmosphere. It was therefore agreed that an environmental burden approach might provide additional meaningful measures of the potential environmental impact of a substance releases. This methodology was followed to complement the customary practice of merely reporting the weight of substances discharged.

In the course of the environmental accounting project, it appeared that corporate requirements about HSE performance were likely to intensify. In July 2003, the Board of

Management requested an internal evaluation to assess the eligibility for the Dow Jones Sustainability Index (DJSI). It was the intention of the corporate Board to be accepted in the index as best-in-class company of the chemical sector in the medium term. The index was chosen as the most prestigious benchmark among the SRI indexes available in terms of international reputation (source: internal communication). The business units needed to provide detailed information to receive the approval from SAM Management, a rating company in charge with the evaluation of environmental and sustainability profile of corporations aiming to be short-listed in the DJSI. DeltaChem was already in the position to satisfy the request advanced from the corporate department to raise data concerning, for instance, greenhouse gas emissions. In the same period, initiatives around climate change were also recognized as increasingly relevant at corporate level. Developments in the Kyoto Protocol implementation persuaded the Board and the top-management to catch up with competitors that were perceived as more proactive on this issue. Further on, it turned out that more corporate actions were carried out to signal the commitment of the company towards corporate social responsibility. For instance, the headquarters adhered to the World Business Council for Sustainable Development with a public announcement on the corporate web-site. Particularly crucial as catalyst of these and other activities around sustainability was the active role played by the new CEO who had been appointed in 2003.

A further milestone in the project was the appointment in May 2003 of a new internal project coordinator formed jointly by a plant controller and a former plant manager in one of the facilities. The newly formed team completed the inventory of current practices and available parameters. A list of about 180 parameters (i.e. QHSE key performance indicators) was completed, and definitions were discussed and ratified to provide uniformity to all reporting units. Moreover, a reporting agenda was finalized to take into account all possible deadlines for internal and external reporting. After concluding this inventory phase, an updated timetable to implement the procedure was proposed. Initially, a full implementation was expected before the end of 2004, which also included the preparation of the DeltaChem HSE report for external audiences. However, the expected introduction of the new system delayed.

The main recent developments referring to the second part of 2004 was the selection of the vendor that should provide DeltaChem the Enterprise Resource Systems module to execute the QHSE accounting system. Preferable solutions were given for extant information systems platforms (SAP and Microsoft) to make the environmental accounting system compatible with extant DeltaChem software strategy. The complete installation of the software is expected for mid-2005, thus after three-years of a transitional process that involved at irregular intervals about eight people from two organizational functions located at two organizational levels (business unit and plant level).

The next two sections utilize the material presented so far to explain and discuss the use of environmental performance measures in DeltaChem.

6.4 Case evidence

The case study conducted at DeltaChem revealed significant clues to possible cause-effect relationships about the use of environmental performance measures for internal control and external accountability. In this section, these clues from case materials are analyzed to establish the plausibility of the conceptual model proposed in previous chapters. This approach is consistent with the definition of a *weak theory test* discussed in Keating (1995). The causal-model form proposed at the outset of the project is analyzed, reconsidered and expanded accordingly to include temporal considerations (speed of influence) and potential reverse causation among variables (reciprocal bi-directionality).

6.4.1 Discussion of the measurement model

This section draws case evidence together by discussing the findings in relation with the research question that relates back to the measurement aspects of the model tested in Chapter 5:

> **SRQa** *Did the instruments developed for the survey study reflect valid measures of the constructs of interest?*

Within the limitations of a single contextual examination, the analysis about DeltaChem is proposed as an illustration of the validity of the nomological network object of study. Thus, consistently with the hypotheses formulated in Chapter 3, the concepts of *environmental strategy*, *EMIS sophistication* and *EPMs informativeness properties* should contribute to explain extent and manner of use of environmental performance measures in the case company.

In DeltaChem, documental evidence suggests that the environmental strategy was clearly formulated in the company's business policy and implemented accordingly at the different hierarchical levels. The company's strategic posture towards environmental issues was also aligned with the corporate HSE policy. Given the hazardous nature of the products manufactured and transported, DeltaChem addressed the HSE aspects of its operations with high emphasis on pollution prevention and pollution control. In this respect, DeltaChem is representative of companies in environmentally sensitive sectors in which HSE issues are increasingly integrated in daily business operations and strategy. The close scrutiny of environmental control agencies at local and national level could be interpreted as the main external driver for environmental strategy, since compliance to HSE regulation strictly conditions the way business is conducted in the chemical sector. In combination to legal requirements, however, additional drivers of "greening" could be identified. The goal of eco-efficiency (e.g. in terms of reduced energy consumption) could be motivated on the basis of pure economic arguments. Additionally, issues of legitimacy and market reputation were carefully considered in DeltaChem managerial and operational practices. In line with extant literature focusing on the antecedents of environmental strategy (e.g. Bansal and Roth, 2000), it can be argued that the company investigated illustrates the co-existence of three driving factors (compliance, competitiveness and reputation) that explain the intensity of environmental management.

Every production facility in DeltaChem is obliged to have an environmental management system and an occupational management system in place. Five plants obtained a third-party certification of their environmental management systems according to the international standard ISO 14001. Other certifications were in place for quality management (ISO 9001:2000) and 3 plants were awarded health & safety management certificated systems (OSHA 18001), signalling that the company fully integrated environmental management in its routine operations. Three functional competences (quality, environment, health & safety) were combined under the responsibility of the same manager, suggesting a trend of integration among these fields (Corbett and Kirsch, 2001). With regards to the mechanisms of organizational and managerial control that DeltaChem devised to execute the environmental strategy, a combination of controls have been internally enforced. Technology-based control mechanisms are deployed into formal information systems that allow correction of deviations from production goals. Technology control is therefore a typical *diagnostic* control system (Simons, 2000), which measures the output of a planned and implemented technology strategy, compares actual results against predetermined parameters (i.e. volume, efficiency) and has the ability to correct deviations. The relevance of technology aspects in adapting environmental management to the type of production process is particularly crucial in DeltaChem, provided that for this company technological processes and logistics strictly influence environmental performance levels. The fact that the chemical products are commodities precludes improvement in pollution prevention through product adaptation. Instead, the emphasis is exclusively on process adaptation through changes of manufacturing process that reduce negative impact on the environment (cf. Klassen and Whybark, 1999b). It must be emphasized that this constrain might play a less relevant role in other manufacturing sectors (e.g. personal computers, automobiles, etc…) where the environmental impact of a product might be more dependent on product design, product manufacturing or assembling, product use, or its final disposal.

Analysing further the control features in place at DeltaChem, a set of procedures and internal guidelines serve as tight *action control* mechanisms (Merchant and Van der Stede, 2003). The execution of operational routines needs to avoid potential risks of incidents that would have potential catastrophic consequences. Coupled with ISO 14001 environmental management systems, operation manuals provide a set of formal procedures that create *"organizational routines"*, namely recognizable and documented patterns of interdependent actions involving multiple agents (cf. Feldman and Penland, 2003). On the other hand, *results controls* mechanisms are developed in various forms. A performance management system based upon the HSE data collected at the operational level ensured a continuous diagnostic control of operations and logistics. It is noteworthy that HSE goals were part of the organization's objectives on the basis of a set of indicators used to evaluate performance levels in a number of plants. A gainsharing system that was recently introduced aimed at enhancing the commitment of line personnel also with regards to HSE-related aspects. In addition, the *"HSE Excellence"* program established in 2002 attempted to strengthen the synergies among these systems and reinforce the environmental orientation throughout the company. Taken as a whole, compliance to (external) environmental regulation and (internal) HSE management system created a *boundary control* system (Simons, 2000). Boundary systems are formally stated through codes of business conduct (HSE strategy at corporate and BU level), asset acquisition systems (the investment manual) and, most importantly, operational guidelines. The adherence to industry programs like Responsible Care and voluntary standards (ISO 14001) institutionalise the *external accountability* to external stakeholders and reinforce the *internal controllability* of operations from the higher hierarchical levels. Seemingly, the corporate culture about HSE-related aspects of production, coupled with a strong technical orientation at the facility level, worked as a unifying company *belief control* system (Simons, 2000). The QHSE manager devised an explicit set of organizational definitions (*"HSE Excellence*", *"license to operate"*, *"license to sell"*, *"license to exist"*) that managers can communicate formally and reinforce systematically to provide basic values, purpose, and direction for the organization. In conclusion, as is quite clear from the case description, the high intensity of environmental management practices in DeltaChem makes the company classifiable as a very proactive company in the area of sustainability.

Recall that the instrument developed to operationalize environmental strategy for the survey was conceived from prior literature as a combination of principles and practices of environmental management. The instrument recognized the importance of formalized business statements about sustainability objectives, and particularly emphasized the coordination and communication mechanisms that are necessary elements for strategy implementation. Field evidence supports the contention that environmental strategy denotes a multi-dimensional concept (cf. discussion in Section 2.2.1). The high heterogeneity in the actual practices or systems that firms actually adopt in this area makes it problematic to devise generalizable constructs encompassing common aspects of environmental management. At the same time, the concern referred to measuring environmental strategy at different organizational levels appeared greater after the observation of the case company. In fact, evidence in DeltaChem suggests that strategic considerations about environmental management were substituted away by operational considerations when progressively moving the focus of discussions from BU management to plant's production line. The level of analysis is a crucial issue that needs to be tackled in future attempts to define more reliable and valid instruments of environmental strategy.

There is also a dynamic interplay between strategic choices at different organizational levels, which makes problematic to characterize them exhaustively with the traditional labels of “top-down” or “bottom-up” strategic approach.

Despite the focus of the case was simultaneously on BU and plants’ level, the hypothesized positive association between a proactive environmental strategy and the use of environmental performance measures finds support from fieldwork. The case revealed that the effective implementation of the environmental strategy requires substantial reliance upon results control systems that include environmental performance measures. Similarly to quality management and other operational strategies that were examined in relationship with management control systems’ design and use (e.g. Abernethy and Lillis, 1995; Ittner and Larcker, 1995; Perera *et al.*, 1997; Hoque and Alam, 1999; Van der Stede *et al.*, 2003), field observation confirmed that the use of environmental performance measures represents a necessary condition for an effective implementation of an environmental strategy. Performance measurement systems facilitate internal control for planning and decision-making, as well as external communication and reporting, because they establish measures that define performance and set goals for improvement. It can be argued that DeltaChem is representative of companies that tend to move away from *exclusive* reliance on traditional accounting-based measures, and include instead other dimensions of performance in their planning and control systems. Consistently with the *Congruence* type of fit illustrated in Gerdin and Greve (2004), it can be expected that the emphasis put on environmental performance measures is pivotal to the achievement of proactive environmental strategies. Strategy and performance measurement systems are required to be aligned if organizations want to achieve their objectives, in accordance with contingency-based research in management accounting (Otley, 1980; Fisher, 1995; Chapman, 1997; Otley, 1999; Chenhall, 2003).

Concerning the differential use of EPMs for decision-making (decision-facilitating) and decision-control (decision-influencing) discussed in Chapter 2 and Chapter 3, the case reveals that the effective implementation of a proactive environmental strategy simultaneously rely upon both uses. Planning and control roles of EPMs jointly interacted to steer the organizations toward the achievement of HSE objectives. Formal procedures were employed for capital budgeting purposes that incorporated an evaluation of environmental-related impact of new investments. Similarly, performance evaluation included environmental dimensions of performance at the operational level (objectively through the gainsharing scheme) and at the BU level (through subjective managers’ review). Field evidence, nevertheless, confirms that the priority given to formal, incentive scheme appears constrained by the specific institutional context that characterizes the industrial relations at the country level. In addition, cultural aspects might play a relevant role in explaining differences among labor contracts. The disparity in the design of incentive scheme was exemplified by the diversified incentive structure within DeltaChem in the countries where the company operates. Factors associated with the organizational structure of multinational companies appear to interact with local context to affect design and use of management control systems (Whitley, 1999; Groot and Merchant, 2000). The interplay among control mechanisms in multinational organizations seems particularly complicated in the area of environmental management where diversity of regulatory regimes and social institutions increase the difficulty to appropriately match the environmental strategy with homogeneous solutions for the various subsidiaries. This topic was not addressed in the case but it is worthy of future research.

It must also be said that the choice of conceptualizing the sophistication of EMIS relying upon four dimensions (availability, scope, timeliness and accuracy) seems valuable and insightful. In describing the development of the environmental accounting project, all these dimensions were object of discussion about the design of the revised environmental performance measurement system. Concerning the *availability* of EPMs, note that the list of HSE parameters to be entered into the HSE accounting systems was predominantly based on resource, output and efficiency non-financial measures (refer to Section 4.4). The scope of the environmental information systems could be classified as *broad*, because the information generated by the EPMs reflected internal and external environmental performance dimensions. The *timeliness* of reporting was particularly high given the need to respond to potential uncontrollable effects in the production or transportation phase. Finally, talking about *accuracy*, case evidence revealed the presence of internal assurance service through periodic audits aiming at checking reliability of the data. Auditable software and procedures were object of analysis and aspects of improvement were suggested as final output. It appears, thus, that the four dimensions appropriately capture sophistication aspects of an (environmental) information system, even though other dimensions could be identified to reflect the construct. On the relevance of the *accuracy* dimension, the QHSE manager commented that:

> *"Talking about accuracy of the environmental performance measures, accounting people are not prepared to understand this type of data. Reliability and consistency in measurement is more important than accuracy. Accuracy refers more to the issue of having the technical measurement instruments. Employing sophisticated monitoring devices can solve it. By the way, advances in science will continuously move forward our knowledge about environmental effects, also due to more precise tools and techniques"*.

A second set of implications refers to the constituent parts of the model linking environmental strategy and the use of EPMs for internal control through the mediating effects of agency-theoretic properties of environmental performance measures. As I already emphasized in the survey study part, the interpretation of case events to make sense of the characteristics labelled as *congruence*, *sensitivity* and *precision* is complicated by the difficulty to translate these concepts from analytical models to a real-life setting. The challenge of the survey to empirically distill informative properties from the respondents provide even greater problem of interpretation in the fieldwork. The case analysis is challenging for two reasons. At first, the case highlighted the presence of an extremely varied composition of performance measures in the area of environmental management. The presence of multiple (predominantly) non-financial indicators does not enable to draw generalizable conclusions applicable to the heterogeneous portfolio of environmental performance measures. Secondly, it is important to distinguish that these properties, at least in the perceptions of the personnel, might elicit different opinions in depending on the organizational level in which they are employed. Thus, for instance, it is plausible to expect that managers at the BU headquarter would perceive emissions of pollutants (e.g. GHG emissions) as particularly *in*sensitive measures of their performance, since their ability to affect the emissions level in the production facility is remotely and indirectly related to their effort levels. In this respect, through discussion with plant personnel it was most noteworthy for instance that the gainsharing scheme induced dissatisfaction at the facility level because of the perceived lack of sensitivity and precision of (some) performance measures. Among them, environmental measures could be arguably criticized for not being informative of personnel's effort, being them completely dependent upon the input/output relationships completely constrained by the design of the production process.

Interestingly, the QHSE manager made clear in various conversations that relying upon formal reward schemes would have not increased employees' commitment to environmental-related issues. Cultural and personnel controls were considered instead as much more effective mechanisms of control in this area, in combination with tight action controls. It is noteworthy that formula-based performance evaluation including environmental performance measures occurred at the level of the facility essentially through the gainsharing scheme. On the contrary, performance evaluation at the BU level relied upon subjective performance evaluation. The case outlines a dilemma in the design of incentive schemes for environmental management that was conceptually described in Chapter 3. Confirming the arguments illustrated in economics-based literature about performance evaluation and rewards systems, in presence of multi-tasking and "hard to measure" activities it could be more appropriate to rely upon fixed wage contracts than incentive-based compensation (Holstrom and Milgrom, 1991). In this vein, Baiman and Rajan (1995) have analytically demonstrated the advantages of relying upon implicit performance evaluation policies. In sum, the specific setting makes difficult to interpret the dimensions of EPMs that were addressed by the survey.

To conclude, the findings of the case suggest that the instruments developed for the survey study possess satisfactory degree of face and content validity. The insights provided by the case confirm furthermore the need to refine those instruments that aimed to capture strategic and design attributes of environmental management and accounting systems.

6.4.2 Discussion and refinement of the structural model

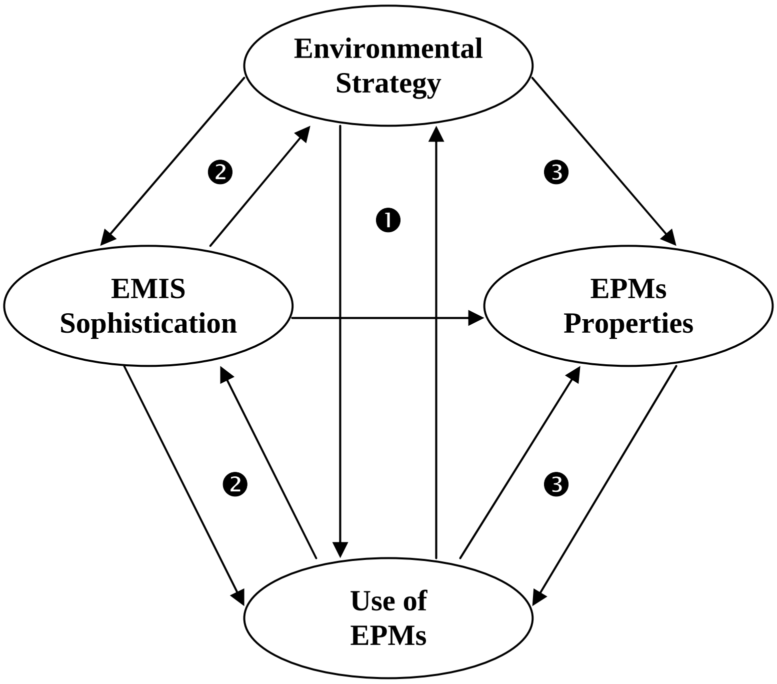
In this section, I focus on the interrelationships among the variables in the attempt to critically evaluate the causal-model form and address the following research question:

> **SRQb** *Are the causal relationships posited by the model confirmed by examining them with a dynamic approach?*

The longitudinal design of the field study allows theorizing about potential mutual influences among variables over time that were not possible to test in the cross-sectional survey study. The field study evidence allows some considerations and refinement concerning the nomological network developed in Chapter 3, which examined static path relationships without analyzing dynamic effects among the variables. This parsimonious model conceptualized environmental strategy as an exogenous variable that was theoretically posited to determine the use of environmental performance measures. With regards to the assumptions of underlying causal-model forms, Luft and Shields (2003) emphasized that collectively researchers' endeavour should be to conceive and empirically test complete recursive models that ideally take into account reverse causality and lagged effects among variables. If this critique is extended to the nomological network developed for this study, the issue of causal-interval length between the two variables remains problematic because organizations might tend to adapt more slowly than others in matching environmental performance measurement systems to their environmental strategy. In the case of DeltaChem, it can be reasonably asserted that the environmental strategy had already crystallized in the short period of time (approximately three years) around principles and practices that were treated as given (e.g. exogenously determined) during the investigation. Nevertheless, it appears that, extending the analysis beyond the specific case, environmental strategy and use of EPMs tend to covary over time at a varying speed. A dynamic mutual adjustment process can be inferred from the case study evidence, with the causal relationship between strategy and use of performance measures can be posited as *cyclically recursive* (Luft and Shields, 2003). This implies that bi-directionality can be conceptually modeled between environmental strategy and use of environmental performance measures, such that a gradual mutual adjustment can occur between the two variables at an identifiable time interval (Covaleski *et al.*, 2003). It also implies that explanatory models based on reciprocal non-recursive explanations are not valid representations of causal relationships in this empirical context. Hence, it is important to acknowledge that the assumption of equilibrium, which is taken as implicit in many of prior research adopting a contingency-based approach, is problematic in this empirical setting.

The reciprocal effects of environmental strategy on the use of environmental performance measures can therefore be illustrated in Figure 6.1. These lagged mechanisms of change were not – and could not be – appropriately detected by the cross-sectional study. Another weakness of the survey results referred to the partial corroboration of discriminant validity between these two constructs.

Figure 6.1 – Modified conceptual model that includes recursive relationships



Note: the circled numbers represent the plausible temporal priority in the model. The recursive relationships between environmental strategy and use of environmental performance measures are expected to occur more rapidly than changes in the sophistication of environmental management information systems. The informativeness properties of the performance measures are affected by strategic choice, indirectly through the sophistication of the measurement system.

The observation from the field study suggests that the concept of environmental strategy indeed adds to explaining the extent to which DeltaChem uses environmental performance measures for internal control and external accountability. However, the case illustrates that, whereas strategy can be considered as a necessary antecedent of performance measurement choice, the performance measures needed to exhibit acceptable levels of quality and reliability before they could be used for planning and control purposes. In DeltaChem it was apparent that the extent to which environmental performance measures were used was dependent upon the sophistication of its environmental management information system. There was formal evidence of an articulated system of collection and reporting of HSE parameter and performance indicators to fulfill planning and control requirements at operational and business unit level. The relevance of designing and maintaining a more sophisticated information system to provide accurate and timely data emerged from the recognition of extant weaknesses at the outset of the, so-called, environmental accounting project. As described in Section 6.3.4, the current environmental performance measurement system consisted of a local, operational accounting system. The collection, generation and reporting of HSE data was object of a process of internal and external reporting, though along lines of internal accountability that were not yet fully systematized. The measurement process was executed and maintained by local technical functions. Moreover, numerous performance measures were currently available in different format or in different information systems. It was also apparent that, due to the highly complex nature of the environmental-related data, definitions and algorithms of environmental performance metrics still arouse problems of definition/interpretation. Some definitions and standards appeared problematic, given the lack of consensus about the measurement method regarding the same metric that needed to be disclosed to, for instance, corporate functions or to external environmental control agencies. Contrary to the analysis provided in Vaivio (1999a) where non-financial measures created the "hard" facts which reduced ambiguity, it was noteworthy that the argument oftentimes advanced about the perceived higher reliability of non-financial over financial cannot be generalized to all non-financial performance measures. The events in the case organization indicate that non-financial performance measures, exemplified by the list of environmental parameters, not always rely upon a perfectly objective measurement technology or algorithm. The QHSE manager reflected on this issue:

> *"Measurement is a typical dynamic process. Some environmental issues might also disappear, because the use of certain raw materials is abandoned, or process technologies are substituted. As a consequence, the environmental parameters tend to change. Aspects that were not considered significant few years ago might emerge again due to increased knowledge about a phenomenon or because of their relevance in the society has meanwhile changed".*

An illustrative example refers to the measurement of greenhouse gases (GHG) which constitute a critical issue regarding climate change and taxation on polluting emissions (WBCSD-WRI, 2004). Direct measurement of GHG emissions by monitoring concentration and flow rate is not common. Sometimes, emissions may be calculated based on a mass balance or stoichiometric basis specific to a facility or process. However, the most common approach for calculating GHG emissions is through the application of documented emission factors. These factors are calculated ratios relating GHG emissions to a proxy measure of activity at an emissions source. In this area, measurement uncertainties associated with GHG inventories can be broadly categorized into *scientific uncertainty* and *estimation uncertainty.* Scientific uncertainty arises when the science of the actual emission and/or removal process is not completely understood. For example, many direct and indirect factors associated with global warming potential (GWP) values that are used to combine emission estimates for various GHGs involve significant scientific uncertainty. Analyzing and quantifying such scientific uncertainty is extremely problematic and is likely to be beyond the capacity of most company inventory programs. Estimation uncertainty arises any time that GHG emissions are quantified. In turn, estimation uncertainty can be further classified into two types: *model uncertainty* and *parameter uncertainty*. Model uncertainty refers to the uncertainty associated with the mathematical models used to characterize the relationships between various parameters and emission processes. For example, model uncertainty may arise either due to the use of an incorrect mathematical model or inappropriate input into the model. As with scientific uncertainty, estimating model uncertainty is likely to be beyond most company's inventory efforts; however, some companies may wish to utilize their unique scientific and engineering expertise to evaluate the uncertainty in their emission estimation models. Parameter uncertainty refers to the uncertainty associated with quantifying the parameters used as inputs (e.g., activity data and emission factors) into estimation models. Parameter uncertainties can be evaluated through statistical analysis, measurement equipment precision determinations, and expert judgment. Quantifying parameter uncertainties and then estimating source category uncertainties based on these parameter uncertainties will be the primary focus of companies that choose to investigate the uncertainty in their emission inventories. Given that only parameter uncertainties are within the feasible scope of most companies, uncertainty estimates for corporate GHG inventories will, of necessity, be imperfect. Complete and robust sample data will not always be available to assess the statistical uncertainty in every parameter. For most parameters (e.g., liters of gasoline purchased or tonnes of limestone consumed), only a single data point may be available. In some cases, companies can utilize instrument precision or calibration information to inform their assessment of statistical uncertainty. In alternative, to quantify some of the systematic uncertainties associated with parameters and to supplement statistical uncertainty estimates, companies will usually have to rely on expert judgment. The problem with expert judgment, though, is that it is difficult to obtain in a comparable (i.e., unbiased) and consistent manner across parameters, source categories, or companies. For these reasons, almost all comprehensive estimates of uncertainty for GHG inventories will be not only imperfect but also have a subjective component and, despite the most thorough efforts, are themselves considered highly uncertain.

The effort to homogenize the different management systems within DeltaChem required a more streamlined approach in information management and reporting. Such information processing eventually aimed at helping management to concentrate on strategic issues, while maintaining a decentralized structure in operations management. Taken together, these observations are indicative that *measurement*-related factors play an important role in performance measurement adoption and use (e.g. Shields, 1995; Anderson and Young, 1999; Cavalluzzo and Ittner, 2004). In general, difficulties in defining and developing appropriate performance metrics in hard-to-measure activities are a major impediment to system implementation and use. Information system problems deter the use of performance information for performance evaluation and rewards. The importance of technical aspects appears to play a more important role in the implementation of performance measurement systems than it does in cost systems implementation (e.g., Anderson and Young, 1999). The case provides an illustration of the pervasive need to “get the information system right” before using the performance measures generated by the system for *results control* purposes. Reliable and valid information is posited as necessary condition to fulfill the requirements of appropriate information systems. This analysis would not substantially differ with respect to traditional accounting information systems. However, what differs in this setting and makes the tensions more explicit is most likely the argument that the sophistication of EMIS appears to require a longer adjustment or calibration phase to match with more advanced environmental strategy implementation. Two main reasons can be advanced to speculate a longer lagged effect. Firstly, the standardization process that characterizes environmental performance metrics is still in its early phase. Provided that widely agreed performance measures definitions have not yet been ratified at international level and an institutionalized framework of accounting standards has not been developed yet, it is not unexpected that companies tend to de-emphasize this type of indicators for the moment (demand-side explanation). The scientific and measurement uncertainty that surrounds, for instance, GHS emissions just illustrated above appears to have generated different measurement protocols that differ from sector to sector. Companies might opt for a wait-and-see strategy and delay the adoption of internal carbon market mechanism until these uncertainties are solved. Secondly, the available information technology that might help the diffusion of these performance measurement systems is also in its early stages. The standardized IT solutions to streamline measurement and reporting of environmental performance measures remain confined to a market niche with relatively high costs of customization and adaptation to extant accounting-based information systems (supply-side explanation). As a result, and not unreasonably, most companies seem to experiment with varying degrees of financial and organizational support into the sophistication of environmental management information systems in response to the institutional or contextual uncertainty concerning measurement issues in this area.

In terms of speed of variation and lead-lag effect, the events associated with the environmental accounting project indicate that the causal interval affecting the degree of EMIS sophistication was substantially longer than the relationship linking strategy and EPMs. The initiative took approximately three years before organizational procedures and software platform for the revised environmental information systems were eventually put at work. Referring back to the conceptual model, it can be argued that the length of the causal interval observed in DeltaChem was definitely longer for the path relating environmental strategy and EMIS sophistication than for the link connecting environmental strategy and the use of EPMs. Figure 6.1 depicts the presence of plausible temporal lags between environmental strategy and use of environmental performance measurement system sophistication.

To extend the model further, it can be speculated from fieldwork that the measurement aspects of environmental information systems were not neutral in terms of perceived congruence and informativeness of the performance metrics. Additional conceptual linkages need to be examined. For instance, timeliness and sensitivity appear as highly interrelated concepts. It can be posited that reduced time-lags in the provision of information might have an effect on the perceived ability of the performance measure to reflect an employees' effort to improve that dimension of performance. Likewise, accuracy and precision appear not conceptually disjoint, provided that more objective and reliable information are in principles conducive of more controllable performance measures. It can be advanced therefore that EMIS sophistication is an intervening variable between strategy and perceived properties of performance measures. The direction and temporal lag of the causal-path is controversial. It seems less plausible to postulate that the properties of performance measures causally affect the dimensions of an information system. Figure 6.1 suggests therefore a unidirectional relationship that needs to be explored further in future research.

6.4.3 Further discussion about consistency of use and level of analysis

Another issue addressed by the second research question of this dissertation concerned the *manner* in which environmental performance measures are used (cf. Section 3.2.1 and Section 5.5). The consistency between two uses – internal control and external accountability – was considered a relevant aspect to examine, particularly in the light of the arguments advanced by prior studies in social and environmental accounting. A further discussion is proposed in this section dealing with the research question:

> **SRQc** *Did the survey study appropriately capture a consistent use of environmental performance measures at different levels of analysis?*

The case study revealed that the reliance upon performance measures for internal and external accountability differed as a function of the hierarchical level involved. At the operational level, the use of environmental performance measures was tightly coupled with operational decisions concerning various aspects of production. Environmental metrics served the purpose of tracking efficiency of production flows, particularly with respect to energy consumption and emissions. Detailed indicators were routinely measured by line personnel and reported to plant management to feed the operational budgets. It appeared that a marginal fraction of the performance metrics selected for the gainsharing program for the personnel employed in a number of facilities were environmental-related. Instead, a larger number of HSE performance measures were considered when evaluating managerial performance. The disclosure of these indicators relied upon different formats and levels of aggregation to take into account internal (e.g.

plant personnel, business unit management, corporate environmental function) and external (e.g. local communities, press, environmental grassroots organization) recipients of this information. At the BU-level, environmental performance measures were periodically reported and analyzed in management reviews. It was evident that these metrics, similarly to other operational measures, allowed creating an *interactive control* system (Simons, 2000) between the two levels over detailed operational issues. Improvements in measurement and reporting systems were recognized by the QHSE manager to allow for the identification of more “strategic” information. In fact, one of the objectives of the environmental accounting project was exactly to address the increased need of data with a higher emphasis on strategic uncertainties and risks. A more limited amount of data was disclosed to external stakeholders on behalf of the business unit as reporting entity. Finally, at the corporate level aggregated and synthetic use of a limited number of indicators (five parameters and targets for 2005) were consolidated predominantly for external reporting purposes. The Board of Management reviewed the actual level of performance along the five dimensions and performed a benchmarking across business units. The actual level of the parameters is publicly disclosed in the annual HSE report.

On the basis of the evidence at DeltaChem, three arguments can be advanced about the *manner* of use of environmental performance measures. First, it seems plausible to affirm that the external reports issued for accountability purposes at different levels of the organizations were a by-product of internal mechanisms of control. Specifically, HSE information collected at the operational level was aggregated at business unit level and consolidated at the corporate level in the annual HSE report. The decreased amount of HSE data that was used at higher level of the hierarchy is consistent with the existence of a “hinge” between lower and higher organizational levels as described in Euske, Lebas and Mcnair (1993). Second, and in relation to the first aspect, it is extremely difficult to assess the issue of consistency among uses without taking into account the different uses at different levels. At a first glance, the marginal focus on five HSE performance targets at the corporate level might suggest a poor coupling between the information disclosed and the information available. In reality, the choice of the Board of Management responds to logic of simplicity in communicating objectives in an area with a large amount of performance measures involved that is often difficult to understand for non-specialists. Third, the company devised tight control systems that routinely drove the operational planning and control, also with regard to HSE performance. Managers need first to carefully select this type of information – and present it under an appropriate format – before disclose it to different external audiences, each with different agendas and information needs. In accordance with institutional arguments about the use of management accounting information, the development of performance measurement both inside and outside the organization is linked to developments in broader sub-systems such as politics, economics and law. The evidence gained from DeltaChem suggests that the traditional role of accounting as rational systems has been expanded and modified to include concurrent or complementary roles. Different dimensions of accounting information use in organization have been suggested in prior literature (Burchell, Clubb, Hopwood and Hughes, 1980). The matrix proposed by Ansari and Euske (1987) was used to illustrate the dichotomies among roles of accounting information in organizations (refer to Table 3.3 in Section 3.2.1). The distinction was made along the extremes of internal/external use, and technical/legitimizing role of accounting information. Field evidence demonstrates that different uses coexisted with respect to environmental performance measures. However, the specific organizational and operational factors observed in the case company appear to confirm the preeminence of internal and technical-rational use of this type of measures. The company historically developed an internal performance measurement system that served primarily internal decision-making and control purposes. DeltaChem represents a proactive company in which the legitimacy role associated to environmental reporting has an important function but the usefulness of EPMs seems predominantly associated with an internal use. It is interesting to note that at country level a broader debate is currently developing concerning the effectiveness of environmental reporting policies that makes environmental information mandatory (recall the discussion in Chapter 3, Section 3.2.1 and Chapter 4, Section 4.2.3). This type of discussion shares similarities with extant debate in accounting with respect to the suitability of imposing compulsory reporting mechanisms for intangibles (Maines, Bartov, Fairfield and Hirst, 2003) and particular typologies of non-financial information (Maines, Bartov, Fairfield and Hirst, 2002).

To conclude, consistently with the model posited in Chapter 3, the findings suggest that technical aspects of performance measurement partially explain extent and manner of use of EPMs. A carefully formulated environmental strategy needs to be supported by reliable and valid information systems for internal use and external reporting. The use and usefulness of EPMs is conditional upon the degree of sophistication that should enable to track the results regarding HSE performance. The static model developed in Chapter 3 using a deductive approach from prior management accounting research should be extended to take into account lagged effects and recursive relationships among variables.

The case study illustrates also how performance measurement change is affected in a particular historical time by contextual and institutional aspects functioning as barriers or catalysts of innovative management accounting systems (Foster and Ward, 1994). In particular, Luft (1997:191) claims that under certain common conditions (e.g. increasing returns to adoption), observed technology choices can arise from path-dependent change or “historical lock-in”. In such cases, random events in the past exert important influences on subsequent choices and the efficiency properties of accounting systems are not sufficient to explain why they are in use. Under these conditions, contingency-based theories about performance measurement choice remain pertinent to understand extent and manner of use of results-oriented control systems. However, additional factors inherent to processual aspects of change appear to be valid explanatory variables as well and alternate theories might provide a richer explanation of the adoption. The next section extends the case analysis by focusing on processual aspects of change and stabilization of management accounting systems.

6.5 Extending the analysis to processual aspects of change

The case study allows exploratory findings concerning the third research question formulated at the outset of the dissertation:

> ***RQ3a*** *How do processual aspects of management accounting change affect the integration of environmental performance measures in traditional management control systems?*
>
> ***RQ3b*** *What is the role of the accounting and control function in the integration process?*

The analysis is developed around two current debates in management accounting research that were recently reviewed in Luft and Shields (2003). The first topic is rooted in previous research that studies intra- and extra-organizational factors affecting change in management accounting and performance measurement system. The second issue concerns the role of technical and accounting functions in performance measurement change and the integration of, so-called, operational and financial realities. It is argued that the case organization outlines interesting insights in both debates, specifically when referring to the implementation of the environmental accounting project. The next two sections briefly introduce the research topics, describe field evidence at DeltaChem and analyse the main results from the case observation.

6.5.1 Intra- and extra-organizational factors affecting management accounting change

Implementation of management accounting change has been object of empirical research largely based on organizational theories about change (refer to Struckman and Yammarino, 2003 for a recent review on this literature), or about diffusion of (administrative) innovation rooted in the seminal work of Rogers (1995) and Abrahamson (1991).[8] Most of the empirical studies apply these theories to the adoption and diffusion of Activity-Based Costing technique (see Map D in Luft and Shields, 2003:219). In many respects, it is not completely appropriate to examine diffusion of innovation in the context of environmental accounting, provided that a well-agreed definition of the object of innovation is not available yet. At present, environmental accounting comprises a combination of varying cost accounting, performance measurement and reporting techniques. The overlap of these practices with traditional techniques makes it difficult to examine adoption and diffusion processes, if compared to relatively well-defined innovations like Activity-Based Costing. In addition, the case company had already adopted a rather sophisticated environmental performance measurement system that actually needed further refinement. This element impedes the analysis of an adoption process "from start to end". Hence, other management accounting studies in the same stream focusing on process models of implementation of management accounting change appear to be more readily applicable to examine this empirical setting. These studies assume that implementation of management accounting change constitutes much more than the selection of what may be perceived as "technically optimal" accounting systems. More importantly, change implementation and change management involves relevant behavioral and cultural aspects that must be understood. Different assumptions and theoretical antecedents characterize these studies. It is not the purpose here to be exhaustive in terms of reviewing the literature on accounting change (cf. Burns and Vaivio, 2001).[9] I refer here to a limited number of papers that examined change in performance measurement systems (Waggoner *et al.*, 1999; Kennerley and Neely, 2002). Among them, Vaivio (1999a; 1999b; 2004) focused on the introduction of non-financial performance measurement adopting an interpretative perspective. In turn, Chenhall and Langfield-Smith (1998a), Hoque and Alam (1999) and Malina and Selto (2004) recently provide positive accounts of performance measurement change. Despite the theoretical and methodological differences, these studies have in common the analysis of a series of factors that were empirically observed during the change process. In what follows, I will examine the elements that were perceived as main catalysts of the environmental accounting project during the duration of the research collaboration at DeltaChem.

Evidence from fieldwork for a relatively short period of time suggests that the main drivers of change originated primarily from *intra-organizational* factors. On the other hand, and similarly to the setting examined in Vaivio (1999b:428) with a focus on quality-related performance measurement, the observed change at DeltaChem did not take place within an extra-organizational void. It appears that the interplay between endogenous and exogenous factors affected the way environmental-related performance measures have been conceived, collected and reported (refer also to the empirical study by Bhimani, 2003 and his comments about paucity of studies that examine at the same time internal and external factors of management accounting change).

In an attempt to theorize on the interplay among these forces, Table 6.6 comprises a list of the main factors or events affecting the development of the renewed environmental accounting system. The analysis is partly based on the framework in Waggoner *et al.* (1999), but also on prior studies drawing on new institutional theory (cf. Granlund and Lukka, 1998; Granlund, 2001). Whereas some of the factors are conceptually located at the level of the organization or the individual manager (*micro*-level), other aspects extend to the institutional context (*macro*-level). Most factors are strictly intertwined, so that it appears problematic to separate them from each other.

Table 6.6 – Catalyst factors affecting the environmental accounting project

<table>
<tr><th>Intra-organizational (endogenous) factors</th><th>Extra-organizational (exogenous) factors</th></tr>
<tr><td>
Internal influences:

Managerial needs for improved performance measurement systems in the area of Quality, Health & Safety and Environment (QHSE)
QHSE objectives clearly formulated in the Business Unit strategy
Appointment of a new Business Unit QHSE manager
Top-management commitment to the project and organizational culture
Organizational slack both in terms of financial and human resources
Engagement of accounting and controller’s function at plant and Business Unit level
Research collaboration with an academic institution
Internal expertise about information technology and Enterprise Resource Planning systems
Existing Accounting Information Systems (AIS) allow integration of a dedicated module for environmental performance management
Appointment of Corporate Social Responsibility manager at corporate headquarter

Process issues:

Adoption of a homogenous set of QHSE-related performance indicators for plants and Business Unit
Consistent approach to measurement of QHSE performance formalized in a new reporting procedure
Enterprise Risk Management project carried out as parallel initiative by external consultant
Corporate-driven initiatives affected by the change of CEO with renewed emphasis, among others, on climate change issue and ranking in the Dow Jones Sustainability Index

</td><td>
Evolutionary tendencies at sector level:

Advances in scientific evidence and in measurement technology of harmful effects associated with chlorine production
Current societal debate regarding chlorine production, usage and transport chain that involves multiple stakeholders
Implementation of EuroChlor’s mercury emissions reduction policy
List of Sustainability Indicators issued by EuroChlor to improve external accountability and allow benchmarking within the sector

Evolutionary tendencies at international level:

Developments and initiatives related to Sustainability or “Triple Bottom Line” Reporting (e.g. Global Reporting Initiative, Dow Jones Sustainability Index and other Socially Responsible Investment funds; forthcoming carbon market of greenhouse gas emissions under the Kyoto Protocol)
Standardization of increasingly integrated management practices in the area of QHSE through the adoption of voluntary certifiable management systems (ISO 9001, ISO 14001, OSHA 18001, SA 8000, and so forth)
Effects of Sarbanes-Oxley Act and other corporate governance schemes on internal control systems
Evolution of AIS and of environmental management information systems
Shifting boundaries of (management) accounting as discipline and (management) accountant as profession

</td></tr>
</table>

Regarding the internal aspects, the need of the Business Unit management to obtain more systematic measurement and reporting of environment-related information from local operations triggered the improvement of the environmental accounting system. The presence of a clearly formulated environmental strategy provided the appropriate framework to develop an enhanced performance measurement system. There was recognition of an "information gap" (cf. Galbraith, 1973)[10] that needed to be closed between the current system and the renewed emphasis on environmental-related information that would serve the execution of the environmental strategy. Apart from strategic considerations, the case confirms that behavioural and organizational aspects appeared extremely important to prompt change in performance measurement systems. DeltaChem's management commitment for the project can be considered as a forceful change factor. In particular, the QHSE manager can be typified as an "innovator" or "internal champion" similarly to prior empirical research on diffusion of management accounting innovations (e.g. Cobb *et al.*, 1995; Shields, 1995; Kasurinen, 2002).

In fact, he felt particularly involved in the project by having initiated the change process and maintained an active coordination role during design and implementation phase. A sponsorship process was in place to explore and articulate the merits of the "innovation", and gain personnel's support for acting in accordance with the project. In essence, linkage to business strategy and top management support were of primary importance for the successful accomplishment of the project. Further, adequate human and financial resources to facilitate change were available at the time the project was carried out. It can be suggested, at risk of oversimplification, that organizational slack is needed to initiate and execute change in performance measurement systems. This would lend support to the argument that financial performance leads to improvement of environmental performance, in contrast with the focus of most empirical research in environmental management and environmental accounting that attempted to establish a link positing a reversed causal direction (cf. Section 2.2.7). Among the implementation tactics that were followed by the QHSE manager to engender change, the research collaboration with an academic institution also added to the credibility of the initiative. In addition, the project was well aligned within existing technical reporting and accounting mechanisms, thereby favouring the involvement of the accounting and controllership function at the Business Unit and plant level. Aspects related to accounting information systems and information technology were equally important to facilitate change. The company was well prepared to introduce a novel software application that was suitable for extant ERP-based information systems.

Processual aspects of change were evident particularly with regards to the dynamics emerging within the environmental accounting "task force". The project brought together accountants and technical personnel to work together and design the new performance measurement system. The inventory of existing practices and the development of common definition/metrics turned out to be a time consuming exercise in the first phase of the project. This activity appeared as the main delaying factor of the project, but it was necessary to identify gaps and coordinate further actions. The discussions within the task force were constructively used to share information that was previously maintained at different local levels. Some of the encountered problems could have been avoided by appointing an external consultant, though at the expense of internal commitment creation. Another important set of drivers referred to initiatives originated at the corporate level. Seemingly, the change of CEO denoted a renewed emphasis over sustainability concerns, with the effect of rolling down to BU's and facilities various corporate initiatives around, among others, climate change (i.e. participation to future carbon market mechanisms) and Socially Responsible Investment (i.e. adherence to Dow Jones Sustainability Index as medium-term corporate objective). An additional not negligible factor that apparently was contiguous to the environmental accounting project was the internal initiative on enterprise risk management (ERM). ERM enables firms to take an integrated approach to managing risk shifting the focus of risk management from defensive, to offensive, and finally strategic (Liebenberg and Hoyt, 2003). The concept of risk has become central to corporate governance and has become strictly intertwined with internal control (COSO, 2003; Spira and Page, 2003). Field evidence confirms that environmental risks emerge as significant operational (labelled as *primary risks* in Power, 2004) and reputational (*secondary risks*) categories of business risks. As noted by the DeltaChem's general manager:

> *"I think that risk management is a methodology to identify the right focus from varying business aspects. We use risk management to formulate our actions in our planning and reporting system. Risk management guides us in the discussion around the issues from the Sarbanes-Oxley, and HSE is also important to allocate priorities. All this priority setting has always been made using a risk-methodology approach, now it is more structured. Environmental-related risks are more important as society does not believe anymore what companies are saying. We have to prove that we are in control and risk management is a way to be more accountable".*

Indeed, risk-based internal control has become a dominant image and representation of organizations, further reinforced by the Sarbanes-Oxley Act, which makes it an all-pervasive organizational, legal and regulatory principle which will probably expand beyond its US jurisdiction (cf. the discussion around corporate governance in The Netherlands based on the *Tabaksblat Code*). Risk analysis, the traditional technical domain of risk management, has been subsumed within a larger accountability and control framework. Power (2004) commented further on this matter:

> *"Primary risks themselves may not be amenable to auditing or direct inspection, but the organizational control systems through which such risks are represented can be. In this way, the auditing and public control of risk is achieved indirectly via the inspection of management systems of control. So, the rise of internal*

> *control is part of a macro- and micro-level politics of responding to crisis by creating new risk accountability structures supporting chains of public and private reassurance. … To lack internal controls, or to have defective control systems, is to fail as a legitimate organization".*

When considering external influences to explain change in the case company, several events at the macro-level can be mentioned as catalysts of the environmental accounting project. Laughlin (1991) suggested that organizations might change in response to an external "jolt" or stimulus for change. It can be argued that the type of industry and the institutional context appeared as strong predictors of the DeltaChem business approach towards environmental issues. At the sector level, a great deal of scientific uncertainty has characterized the debate on how to measure - and deal with - the effects of chlorine on the environment and human health. The so-called "toxicity debate" described in Tukker (1999) is particularly acute for this specific substance, since scientific knowledge about chlorine has not yet been able to devise a solution that would satisfy all actors in society. In general, science can play a role in solving controversies like in toxicity evaluation provided that the different actors involved (policy makers, industry representatives and environmental organizations) accept scientific knowledge claims (or "frames"). From the specific analysis of the chlorine controversy, Tukker (1999:350) interestingly concluded that:

> *"There are a number of fundamentally different views on the relationship between mankind and nature and the robustness of nature, of which the rightness cannot be proven. The result is a number of fundamentally different evaluative perspectives and related management schemes for toxicity problems, Robust scientific knowledge has only a limited – though not zero – say in the making of a choice between these perspectives, and management options that are acceptable for the most extreme perspectives are generally lacking. So what remains is a socio-political negotiation process in which the few robust knowledge claims, softer information and frames have to be included in order to come to a decision that is the most viable for the time being. But, obviously, under changing conditions, this – social – viability may cease and new negotiations may be necessary. And this is most likely the case for those substances and production processes for which the tension between the evaluative perspectives is most relevant".*

With regard to the controversy surrounding chlorine production, the company was caught into an intense debate specifically focused on the transport of chlorine. The field investigation occurred in a period of reorganization to cope with the demands of governmental agencies that had repercussions not only on the environmental profile of the company but also on occupational levels, logistics and market opportunities. Other evolutionary tendencies can also be associated to the sector policy to reduce mercury emissions and the new list of sustainable indicators to benchmark sector performance, both issued by the European industrial association. The list played a role of *"external* *reference point"* (Vaivio, 1999a) that reinforced the internal credibility of the QHSE strategy, by emphasizing similar initiatives that were diffusing within the same industrial context. The convergence of the key performance measures adopted by the industrial players within the same sector suggests an interpretation consistent with the presence of a *mimetic* isomorphism which can be drawn from institutional theory (DiMaggio and Powell, 1983; Milstein *et al.*, 2002). Thus, the chlorine sector provides a peculiar setting, as emphasized by the DeltaChem's general manager:

> *"There is no other industry in the chemical sector that is collecting data as we do in the area of health, safety and environmental performance. We have always been on the frontline. We have a coherent group of companies in the sector. One product makes easier to set a sector policy and monitor it. For other industrial associations it is more complicated to develop a common line. The reputational effects are indeed enormous, given that you can be highly damaged by what other companies do. That is typical of the chlorine industry".*

Furthermore, a series of factors emerging at the international level supported convergence towards a renewed emphasis on environmental performance measurement systems. Among them current initiatives (like the one sponsored the Global Reporting Initiative, 2002 aiming at standardization of reporting of Triple Bottom Line) increased visibility and consensus in different industrial sectors. Similarly, developments took place concerning the certification of QHSE systems under international standards. In particular, there is evidence of more emphasis on integrated management philosophies that would ultimately translate into integrated certification processes for quality, health & safety and environmental management systems.

It is worth noting that the evolution in accounting information system was another element that affected the development of a dedicated environmental accounting system. The market of software solutions for environmental performance measurement and reporting is limited to some specialized companies or consultancies. In the design and development stage of these systems frequent interaction between developer and user is required to tailor enterprise resource systems on the needs of the customer. As noted by the QHSE manager, the implementation phase of IT was delayed due to the complexity of selecting the appropriate design features that would be integrated in existing DeltaChem SAP system. Therefore, information technology can be described as a barrier to change in the design phase, while it might provide a facilitating role for change once the information system is implemented.

In conclusion, speed, scope and scale of change were dependent in large part on similar factors affecting other innovative management accounting techniques. A non-linear logic of the events that facilitated change was laid out in the case. Therefore, it is hardly possible to identify which factors have been necessary conditions for change, as several events occurred in a relative short period of time. It appears that, in early phases of adoption and use, the external agenda seems to dictate the choice of environmental performance measures. Environmental regulation constrains the choice of performance measures that need to be collected and reported on a regular basis. In subsequent phases, refinement of the information system into organizational routines is likely to occur. Systematic collection of reliable and valid information is needed not only to comply with regulatory requirements but also to fulfill internal planning control. This makes environmental management and environmental accounting a peculiar setting if compared to other operational strategies and related performance measurement systems. Regulatory, competitive and legitimacy aspects of environmental performance measurement systems are intertwined to an extent that is not common in other operational areas. In general terms, the above analysis illustrate that technical and social dimensions of accounting systems are tightly interlinked. The pace of change was dependent upon "assemblages" or combination of internal as well institutional factors (cf. Duncan and Thomson, 1998). The next section discusses more in depth the crucial relationship between accounting *versus* non-accounting systems, and the role of accounting-related functions behind this relationship.

6.5.2 Change process and the relation between "operational" and "financial realities"

In addition to the analysis presented above, the processual aspects of change that emerged during the environmental accounting project can serve to discuss another topic within the literature in management accounting research. I refer in this section to a stream of empirical papers that focused on the dynamic role of management accounting in integrating non-financial performance measurement systems (labelled as *"operational realities"*) into organizational structures and information systems that privilege financial dimensions of performance (labelled as *"financial realities"*). As reviewed in Luft and Shields (2003:233, see Map I), this stream relies upon a variety of social sciences to examine how management accounting affects or is affected by changes in the market, in production policies and in information systems. The issue seems particularly relevant to better understand – lack of – change in environmental accounting when referring to the results of the survey study presented in Section 4.6.1. Two aspects can be outlined from the observations of the events in DeltaChem. The first consideration refers to the *standardization* of environmental accounting. It appears that a systematic codification of environmental accounting as an accounting tool facilitates its integration into accounting systems. About this point, the QHSE manager claimed that:

> *"There is a reason to combine the accounting and technical functions. Financial accounting is based on widely accepted principles. The same should apply to environmental-related data. It helps if internal control systems integrate environmental-related information. You can introduce QHSE accounting within financial reporting using the existing procedures of measurement, consolidation and reporting. It is much easier to adapt the traditional reporting systems to allow the controller to use this information. It gives an equal place to QHSE information*

> *via financial accounting procedures. Alternatively, you need to re-organize the reporting system. Operational measures regarding manufacturing productions are already integrated into our financial-oriented internal reporting and control system".*

The case suggests as well that quantitative knowledge reinforces formal ways of seeing and reasoning in this area, provided that the information migrates from non-financial/technical internal lines to financial/reporting lines of accountability (Meyer, 1986). Quantification and standardization are necessary element to create a "*formalized organizational memory*" (Vaivio, 1999a). Research in accounting has shown that accounting practices can promote a new organizational reality and introduce a new language (e.g. Hopwood, 1987; Dent, 1990; Ogden, 1995; Ahrens, 1997). As noted by Larrinaga-Gonzalez and Bebbington (2001) when discussing resistance to change in environmental accounting and reporting:

> *"…for change to be effective the change agent has to reproduce the underlying rationale of the organization".*

Thus, the objects of organizational attention towards the natural environment have to "fit" into the summarized, standardized and numerically documented format of the traditional quarterly budget in DeltaChem to acquire legitimization. Similarly, environmental risks appear as "*calculative practices*" (Miller and O'Leary, 1994) that allow environmental management operations to acquire more visibility in alignment with a broader assessment of operational risks. As Cooper, Hayes and Wolf (1981) stated:

> *"Internal accounting systems by what they measure, how they measure and who they report to can effectively delimit the kind of issues addressed and the ways in which they are addressed. They reflect the status quo, the appropriate and acceptable ways of doing things and talking about issues".*

To summarize, it can be argued that environmental management accounting is likely to survive within the organization if it reproduces or is in alignment with the underlying rationality of the organization. Internally, interventions that do not reinforce the organization's underlying strategy and structure, may face more resistance in terms of changing an organization's functioning (Larrinaga-Gonzalez and Bebbington, 2001). Systematization helps environmental performance measures to be integrated into the company's management process and turned them into organizationally constitutive artifacts (Vaivio, 1999b:429). At the same time, an increased rationalization of particular institutional sectors of society (as illustrated in the previous section by the "toxicity debate" in the chlorine industry) influence prevalence and visibility of environmental performance measures and their societal relevance (Meyer, 1986). In this respect, both accounting systems and accountants are symbols of rationality for external groups. They therefore play an important role in reifying the abstract qualities of environmental management, environmental performance and accountability that are valued by an organization's external constituencies (Ansari and Euske, 1987:563). On this matter, Llewellyn (1994:11) suggests that accounting is pivotal for both productive activities and communicative interaction and as such plays a role in *"boundary maintenance"* (i.e. organizations seek to maintain their organizational boundary in the face of changing external expectations). In the specific setting of environmental management, increased demands of external accountability are coupled with augmented internal need for planning and control. In combination, it appears that environmental accounting practices tend to occupy a boundary role in the attempt to dynamically reconcile internal and external demands of control.

The second issue regards the ownership of the environmental accounting system. During the period of investigation it was frequent to hear from discussions with the QHSE manager about the necessity to move the environmental function away from exclusively personal task. The same issue has been debated in Miller and O'Leary (1994) referring to the organizational change from a *governable person* to a *governable process*. The observations from DeltaChem suggest further that environmental management is no more belonging to a *functional silos* (see Koehler, 2001), owned by a specialized function isolated from other organizational functions. Prior to the start of the environmental accounting project, important knowledge was stored in field experience and habitual routines, which were developed by single agents in their local working environments (Vaivio, 2004). Specifically, the initiative of starting a systematic analysis of environmental performance measures in DeltaChem can be traced back to a technician working for a laboratory in one of the sites where the company operates. Specific knowledge in the shape of micro-level information systems remained in the service of local management needs, while these measurements were not circulated and widely mobilized in a systematic format. It was recognized that operational action of technical personnel was the arena of a different management expertise than the accounting personnel. Nevertheless, it was decided to allocate the ownership of the systems to both technical and accounting functions. Contrary to the evidence from the case described in Larrinaga- Gonzalez and Bebbington (2001), the goal in DeltaChem was to allow the technical personnel to maintain the ownership of the environmental accounting *content* (contextual and processual knowledge from Rothenberg, 2003; local knowledge from Vaivio, 2004) while leaving the *procedural* aspects of the system to the accounting function. The case illustrated how accounting extends deeper into the operational level as the accounting functions become more involved with technical expertise and unfamiliar (i.e. non-financial) dimensions of performance (Ahrens, 1997). After the implementation of the system it can be expected that organizational power formations (the "technical" personnel *versus* the "accountants") could be destabilized. The natural environment as a new "calculable space" (cf. Vaivio, 1999a) creates new opportunities for *interactive* control between accounting/controllers and other professional expertise (Simons, 2000). The case company revealed an interesting organizational design to attempt moving the accounting profession's interests towards environmental accounting. From prior literature, the role of accountants in responding to the environmental agenda has been marginal as documented by few empirical papers (Gray *et al.*, 1995; Larrinaga-Gonzalez, Carrasco-Fenech, Caro-Gonzalez, Correa-Ruiz and Paez-Sandubete, 2001; Adams, 2002; Larrinaga *et al.*, 2002; Lodhia, 2003). The separation of duties approach adopted by the case company needs to be further investigated to verify its efficacy.

6.6 Concluding comments and limitations of the case study

The events that occurred in DeltaChem are emblematic of companies that currently deal with accounting changes to accommodate non-financial objectives. The case provides insights about the inter-play between management accounting and environmental management. It enabled to explore further the variables and the relationships concerning the antecedents of environmental performance measures, stretching the analysis beyond what might be extended from the questionnaire survey. The fieldwork adds support to the relevance of *technical, measurement* aspects of performance management. The successful implementation of environmental strategy relies upon the necessary development of information systems that are required to deliver environment-oriented data. These data is supposed to show appropriate levels of reliability and informativeness. Similarly therefore to other process management systems (like Total Quality Management), the adjustment of the design of management control systems requires time and financial resources. The case revealed a change project that attempted to refine internal reporting and control system. Without overstating the case, evidence suggests that, contrary to accounting change that affects financial information, the area of environmental management provides additional challenges. In fact, the case yields insights with respect to contextual and processual aspects of change that emphasize two types of tensions. First, the tension between intra-organizational and extra-organizational drivers of management accounting change appeared peculiar in the area. Inertial and catalyst factors were highly interconnected through the investigation, suggesting that speed of changes might differ substantially due to several variables at the micro- and macro-level. Second, the case was helpful for illuminating the potential role of controllers and accountants in facilitating rather than impeding change to accommodate for the need of information in the HSE area. In its current state, environmental accounting still represents "accounting at the margin" (Miller, 1998), thus providing a sort of real-life laboratory to understand how a relatively established field is confronted by evolutionary tendencies that shifts its traditional boundaries. The case company was particularly illustrative of initiatives that tend to exploit professional accounting expertises to establish more streamlined environmental information systems in financial oriented accounting systems.

Overall, it must be also emphasized that the environmental accounting project at DeltaChem did not turn out in a revolutionary, path-breaking discoveries in financially oriented accounting practices. Expectation for radical change in the area of environmental accounting pervades the critical literature in social and environmental accounting (Gray, 1992; Gray *et al.*, 1995; Gray and Bebbington, 2000; Gray, 2002). On the contrary, the case was informative of a change program regarding performance measurement and reporting that illustrates the *evolutionary* nature of change in this area (Burns and Scapens, 2000; Burns and Vaivio, 2001), particularly for companies that have already implemented proactive environmental management practices.

A final comment concerns the weaknesses inherent to the case design. First, cautions are necessary in interpreting the findings of the case study. My analysis of the events in the particular context of the case is obviously subjective, restricted by perceptual biases and certain theoretically informed choices. While the case material support the interpretations made, there is always the possibility that another set of researchers would have reached different conclusions within the same setting. In addition, the modest intervention that characterized my role as facilitator during the research project might have altered the course of events and consequently the results of the study. It can be argued that field-based research cannot divorce itself from the biases of the researchers, particularly in presence of an intrusive research approach typical of any clinical field study. On the other hand, the fact that company's representatives provided positive feedback on the analysis presented in this chapter adds to the robustness of my personal interpretations. Third, the case design could be criticized for the selection of a company that eventually presented idiosyncrasies supporting the theoretical model to be validated. DeltaChem indeed presents specific organizational and contextual features as they unfolded during the project. However, I could have not taken them into account at the outset of the research collaboration, when the richness of the setting was judged a unique opportunity to shed greater light on the subject under investigation that could not be missed. Fourth, as any piece of field research grounded in the events of one empirical site, the study does not allow for generalizations across organizations. In the context of the dissertation as a whole, the lack of external validity of the case is balanced by the survey results that can be generalized to a population of manufacturing companies.

A final weakness of the study refers to the confrontation between company and trade unions about the salary package (including the gainsharing mechanism) that ultimately had an undesired effect on the research project. After the initial phase of the research collaboration, I had proposed to collect data by relying upon an internal survey among DeltaChem employees. The survey would have addressed behavioural effects associated with a performance measurement and incentive scheme that included environmental dimensions of performance. The presence of the gainsharing scheme made DeltaChem also a suitable setting to empirically test behavioural and performance effects associated with group-based incentives, thereby providing a more general contribution to management accounting research on a relatively unexplored subject. The results from this survey would have provided further indications on how to cope with perceived dissatisfaction of the gainsharing mechanism. In parallel, the generation of more useful (informative) QHSE performance measures from the renewed environmental accounting system, at least in the intention of the top management, would have given a wider set of more informative QHSE parameters. Unfortunately, the on-going negotiation between corporate management and trade unions concerning contractual issues prevented the opportunity to execute the internal survey. In conclusion, the qualitative case study resulting from the field research is nevertheless valuable and adds to our knowledge about how performance measurement and control issues are impacted by environmental management. However, the research design had to be modified to face the unexpected situation of dealing with sensitive topics associated with pay-for-performance and other contractual issues in the middle of a labour agreement.

Endnotes Chapter 6

[1] EuroChlor represents 90 European industrial companies employing more than 40,000 people across 21 countries. The sector produces more than 20 million tonnes a year of chlorine, caustic soda and hydrogen. It underpins 60% of the European chemical industry turnover (€521,000 million in 2002).

[2] Electrolysis consists in passing an electric current through the solution of salted water in order to split apart the positive sodium and the negative chloride ions. Electrolysis occurs when direct current electricity flows between anodes (positive electrodes) and cathodes (negative electrodes) through the salt water. Since opposite charges attract each other, the negative chloride ions collect at the positive poles and form molecular chlorine gas. Each time a tonne of chlorine is produced, 1.128 tonne of caustic soda (sodium hydroxide solution) is produced in combination. Chlorine and caustic soda are used as input in approximately 55% of the production of the chemical industry worldwide.

[3] According to the statistics provided by EuroChlor, over the last 15 years the European chlorine industry has reduced its emissions of mercury in effluents by more than 90 percent. Chlorine production units contribute a fraction of one percent to the total emissions of mercury (natural and anthropogenic) released into the environment. The Oslo and Paris Commissions (the major agencies that deal with the protection of the North-East Atlantic Sea) have fixed an emission limit of 2g per ton of capacity installed.

[4] More than 86% of chlorine made in Western Europe is produced and processed or used on the same manufacturing site in order to minimize transportation.

[5] According to Jensen and Meckling (1992) *specific knowledge* is defined as knowledge that is costly to transfer between agents, due to idiosyncrasies of production processes, customers, markets.

[6] Gainsharing is not a single type of incentive program. Rather, it is an umbrella term for a family of aggregate pay-for-performance approaches that link financial rewards for employees to improvements in the performance of the entire unit (cf. Welbourne, Balkin and Gomez-Mejia, 1995).

[7] On late 2004, it turned out that the corporate headquarter extended the list of KPI's for which annual performance measures need to be disclosed (source: corporate web-site). The additional KPI's that will be measured and reported in the future are the following: Occupational illness frequency rate, Total reportable rate of injuries, Number of lost time injuries of contractors, Hazardous waste as a percentage of non-reusable waste, Net energy consumption index, Direct CO_2 emissions, Percentage zero and low carbon power consumption, Fresh water consumption, Number of serious accidents.

[8] Examples of empirical studies referring to these theories are Bjornenak (1997) and Malmi (1999) on the diffusion of Activity-Based Costing techniques in Scandinavian countries.

[9] On one hand, papers like Shields (1995) and Anderson *et al.* (2002) adopted a positivist approach and suggest a series of contingency-factors affecting change. Alternatively, studies like Innes and Mitchell (1990), Cobb, Helliar and Innes (1995), Granlund (2001) and Kasurinen (2002) focus on individual role processual models of management accounting change.

[10] Galbraith (1973:5) defined uncertainty as *"the difference between the amount of information required to perform a task and the amount of information already possessed by the organization"*.

CHAPTER 7

CONCLUSIONS AND DIRECTIONS FOR FURTHER RESEARCH

7.1 Introduction

In this final chapter, I provide concluding remarks about the dissertation. In Section 7.2, I summarize the contents of the dissertation and draw conclusions from the results of the two empirical studies. Next, in addition to the research directions that emerged from the limitations of the two empirical studies discussed respectively in Section 5.4 and Section 6.6, Section 7.3 proposes an agenda of topics that are worth exploring in future studies.

7.2 Summary and discussion of findings

This dissertation examined the role and the implications of management accounting and control in the field of environmental management. The specific research objective was to enhance our understanding about determinants and effects of environmental performance measures in management control systems. A literature review in Chapter 2 emphasized the increased interest about this issue from practitioners' literature in environmental management and environmental accounting. On the other hand, it established that prior academic research in this field is undernourished, particularly when confronted to the amount of financial accounting research focusing on external environmental reporting. Consequently, this dissertation used insights from the empirical literature on performance measurement choice in mainstream management accounting research to develop a conceptual model addressing extent and manner of use of environmental performance measures. The model builds upon two theoretical perspectives (Chapter 3). First, I relied upon a contingency-based reasoning from prior studies that examined the interplay between operational strategies and design of management control systems. From the literature review it appeared particularly fruitful to refer to the literature on quality management, because of the conceptual and practical analogies between the fields of quality management and environmental management. The model posited that a company's environmental strategy is a relevant antecedent of the use of environmental performance measures. In particular, I argued for the existence of an indirect effect affecting the strategy-MCS relationship through a set of information systems' attributes referring to the seminal study by Chenhall and Morris (1986). Moreover, recent exhaustive reviews in empirical management accounting literature emphasized that explanations of performance measurement choice from behavioral-based literature should be fruitfully integrated with the economics-based approach stemming from agency theory. Therefore, propositions were developed to explore how properties of performance measures' informativeness (or incremental information content) are associated with the use of environmental performance measures. Jointly, the model combined two paradigms of mainstream studies in management accounting that investigate design and use of performance measurement and control systems. Further, manner of use of environmental performance measures was object of theorizing, by drawing a distinction between internal use for decision-making and decision-control, and external use for accountability purposes towards stakeholders and shareholders. The difference is particularly important in the field object of study, provided that, in presence of a potential gap between the two uses (so-called "window dressing" or "greenwashing" effect), companies might suffer from lack of accountability and adverse reputation effects towards external stakeholders. Finally, I explored consequences of environmental strategy in combination with the use of environmental performance measures. The analysis of this latter relationship allowed for some preliminary conclusions on the role of environmental performance measures to ensure alignment ("fit") between environmental strategy and environmental performance levels.

Empirical data were obtained from a cross-sectional survey administered as part of a research program sponsored by the *Controllers Instituut* to gather evidence about performance management practice in The Netherlands (Chapter 4 and 5). Survey data were collected on a sample of 81 controllers and financial managers employed in manufacturing Dutch companies. The survey results highlighted a problem of ineligibility of a portion of the respondents. However, the final sample size compares favorably to similar exploratory studies published in management accounting literature. Subsequently, a case study was carried out in collaboration with a European multinational company operating in the chemical sector (Chapter 6). The objective of the case was twofold. It was meant to complement the findings of the survey to qualitatively test the conceptual model proposed in Chapter 3 (*explanatory*, or *theory illustration*, case study approach). The longitudinal design of the case additionally allowed the observation of a dynamic process of management accounting change exemplified by the modification of the company's environmental performance measurement system. In combination, the two empirical studies provide exploratory evidence on determinants, consequences and processual aspects of environmental performance measures' use in management control systems.

The results from both studies addressed *RQ1a* (*What factors explain the use of environmental performance measures in management control systems?*) by broadly supporting the role played by strategy as a relevant contingency factor affecting performance measurement choice. Consistent with expectations, companies associated with a higher intensity of environmental strategy tend to develop a wider range of environmental performance measures. The findings add to the arguments rooted in the contingency-based tradition of management accounting research which contends that a *congruence* type of fit should be present between strategic choice and use of management accounting systems (cf. Fisher, 1995; Donaldson, 2001; Chenhall, 2003; Gerdin and Greve, 2004). More importantly, the results suggest that the presence of a clearly formulated environmental strategy is not a sufficient condition to ensure its implementation. Whereas strategy can be considered as a necessary antecedent of performance measurement choice, the performance measures needs to exhibit acceptable levels of quality and reliability before they could be used for planning and control purposes. The results provide an illustration of the pervasive need to "get the information system right" before using the available performance measures for internal control purposes. The findings from the survey study revealed that specific design features of environmental performance measurement systems have an indirect effect on the use of environmental performance measures. The availability of environmental performance measures fully mediates the relationship between environmental strategy and use of environmental performance. Similarly, this relationship is explained by the perceived sensitivity that managers associate to these performance measures. The insights from the case indicate that is fruitful to continue examining informational attributes related to environmental performance measurement by relying upon both behavioural- and economics-based paradigms of performance measurement choice.

With regard to the issue of consistency of use of environmental performance measures addressed by *RQ1b* (*Is there consistency between the information that is disclosed externally and the environmental performance measures that are used internally for planning and control?*), the study provides weak confirmation of a "greenwashing" effect. The results from the survey study point at a significant difference of use between reactive and proactive group of companies. However, it appears that both groups use environmental performance measures consistently to serve internal and external purposes. Evidence was thus unable to confirm the argument behind much of the literature belonging to the interpretative school in environmental accounting, which has been and remains particularly critical towards the initiatives carried out from corporate business (refer to the review in Section 2.2.2). Caution should be warranted to the interpretation of the result. Data relying upon the survey method may have been affected by common method bias. In addition, the company case appeared as a representative company of proactive organizations in the field of environmental management. Lack of comparison with more reactive companies would have been particularly fruitful to validate the results and extend this line of research in the future.

Further, performance consequences associated with the use of environmental performance measures were explored by the data from the survey study, allowing to address *RQ2* (*Is environmental performance enhanced by the fit between environmental strategy and the use of environmental performance measures?*). The survey findings confirm the presence of a mediation-type of fit, such that environmental strategy positively affects environmental performance levels through the use of environmental performance measures for internal control. Two aspects make the study of the link “strategy-MCS-performance” problematic in this field. First, as previously discussed, a lack of clear definitions and multidimensional aspects of environmental performance posits problems to identify and measure the dependent variable. Second, conceptually modeling causal relationships is particularly challenging in this field. For instance, leading-lagging effects concerning pollution phenomena might be difficult to detect. Possibly, only a longitudinal approach could add to the extant knowledge and carefully replicated studies that build upon reliable data are required. It is important to emphasize that the high fragmentation of research from disparate academic disciplines has not helped to build a coherent body of knowledge concerning the topic of environmental performance measurement and its effects.

Finally, the case study presented in Chapter 6 addressed *RQ3a* (*How do processual aspects of management accounting change affect the integration of environmental performance measures in traditional management control systems?*) and *RQ3b* (*What is the role of the accounting and control function in the integration process?*). Field evidence emphasizes that *measurement*-related factors play an important role in environmental performance measurement adoption and use (e.g. Shields, 1995; Anderson and Young, 1999; Cavalluzzo and Ittner, 2004). In general, difficulties in defining and developing appropriate performance metrics in hard-to-measure activities are a major impediment to the adoption of innovative performance measurement system. However, what makes the setting of environmental performance measurement peculiar is the evidence that the generation and use of these performance measures require a longer adjustment or calibration phase of the management control systems. On the one hand, the scientific and measurement uncertainty that characterizes environmental performance measures continuously affects definitions and measurement technology in a dynamic way. Consequently, the standardization process associated to environmental performance metrics is still in its early phase if compared to other non-financial information. This was apparent during the field study in relation with the definition of key environmental performance indicators. On the other hand, the findings based on the case observation emphasized the complexity of processual elements of organizational change in this area. A combination of internal factors at different hierarchical levels contributed to initiate the change process. Tone at the top and involvement of the environmental function appeared as crucial conditions to further sustain change of performance measurement systems. The cooperation between environmental and accounting personnel appears as fruitful to facilitate change in performance measurement and control mechanisms. At the same time, evolutionary tendencies in the institutional environment emerged as well as key driving factors. The events at the case company suggest that inertia from institutional context might prevail despite the presence of catalysts factors within an organization. Results allow an understanding of why only a minority of companies has already integrated their environmental performance measurement system in their traditional management control systems. Some companies strategically opt for not investing human and financial resources in more sophisticated environmental performance measurement systems in absence of stable and clear definitions of the “rules of the game”. Taken together, the findings suggest that change of performance measurement and control systems in this area appears as more problematic than other empirical settings.

In conclusion, the study sought to explain the extent to which companies currently use environmental performance measures, in the attempt to bridge the theoretical insights from management accounting literature with the emerging field of environmental management. In combination, quantitative and qualitative research methods provide convergent evidence of complex relationships among contextual and organizational features in affecting design and use of environmental performance measures. The study contributes to theory and to the debate around performance measurement choice in different ways. First, the literature review presented in Chapter 2 allowed an organization and evaluation of the multi-disciplinary literatures that investigate environmental management and environmental accounting. The overview is particularly insightful in addressing common areas of research previously addressed by unrelated academic fields and in directing the attention on extant gaps and methodological weaknesses in a novel area of research. In particular, it was apparent that the so-called empirical link environmental performance – financial performance catalyzed the attention of scholarly research from different disciplines. The review argued about the need to further concentrate on theoretical explanation of the link, especially by adopting an internal focus on environmental management and managerial accounting practices. Second, the dissertation attempted to cope with criticisms presented in recent reviews in management accounting concerning the study of performance measurement and control systems. In line with arguments proposed by Merchant *et al.* (2003) the study adopts an integrative research approach in the attempt to bridge two theoretical paradigms on performance measurement design, rooted respectively in behavioral-based versus economics-based paradigms. Furthermore, the study attempts to shed additional lights on strategy-MCS relationships, including an analysis of their dynamic interplay across hierarchical levels. The case study was insightful about the existence of mutual relationships affecting corporate and environmental strategy. Findings can arguably be extended to other strategic areas and suggest interesting implications for research that go beyond static “top-down" or "bottom-up" approaches to study how strategy interacts with MCS. In addition, following the suggestions by Ittner and Larcker (2001), specific informational attributes and performance measurement systems were addressed from prior literature to explain their differential use for internal control and external accountability. This approach is in line with recent pleas to concentrate on theory-driven dimensions of performance rather than focusing on financial/non-financial measures as discriminant attribute. Third, the dissertation emphasized the need to simultaneously consider external and internal effects of performance measurement systems. The specific empirical setting demonstrated how the boundaries among accounting disciplines become increasingly artificial. I believe, for instance, that the debate concerning measurement and reporting of non-financial performance measures (cf. Maines *et al.*, 2002) or disclosures about intangibles (cf. Maines *et al.*, 2003) could derive interesting implications from the study of environmental accounting and environmental reporting practices.

In addition to contributing to theoretical knowledge, the results presented in the study allows for some practical recommendations for practitioners, policy makers and professional accountancy bodies. The empirical findings indicate the central role of measurement aspects in the area as a necessary condition to ensure internal control and external accountability. The results thus suggest that investing in the appropriate performance measurement systems represents the basic condition to control environmental performance. In addition, human resources and organizational change dynamics are crucial elements to increase the likelihood of adoption and use of environmental performance measurement systems. Case study observations highlighted that the involvement of the accounting and control function might work as a facilitating mechanism to enhance change in management accounting systems to accommodate environmental-related information. Implications can be also drawn for policy makers and accounting bodies to emphasize further the need for standardized measurement and reporting guidelines of environmental performance measures. Recent initiatives at sector and international level indicate an increasing convergence of methodologies. Institutional support is thus required to encourage further the integration of environmental accounting into traditional accounting practices.

7.3 Limitations of the study and directions for further research

Despite the insights gained about a relative novel field of research, this dissertation presents limitations that may be valuable to account for in future research. The study suffered first of all of a contextual limitation inherent to the limited diffusion of the phenomenon under investigation. Only a minority of the companies surveyed reported that their performance evaluation and reward schemes had incorporated environmental dimensions of performance. The results clearly indicated that the topic of environmental management control remains marginal, confirming prior findings from surveys of practice carried out in different countries (e.g. Ditz *et al.*, 1995; Epstein, 1996; Bennett and James, 1998a; Bartolomeo *et al.*, 2000; Parker, 2000b; Bennett *et al.*, 2002a). The survey allowed also some exploratory findings regarding the role of accounting and controller's function in the adoption and diffusion of environmental performance measures. Again, similarly to previous evidence (cf. Gray *et al.*, 1995, Lodhia, 2003) the results indicate a marginal place occupied by environmental information in traditional accounting and control systems. It is worth recalling that about 15% of the respondents strongly agreed or agreed to the statement that the environmental performance measurement systems were generated within the accounting information system. More importantly, only 4% of the respondents agreed about the statement that the ownership of the EMIS was under the controller's function. These results suggest that generally the environmental performance measurement system tends to be kept separate from traditional, financial-oriented accounting information systems. In addition, controllers seem not to be responsible for the design and functioning of these systems. At present time, it can be presumed that the EMIS remains under the ownership of other functional departments, presumably the ones in charge of environmental management or manufacturing operations. In this respect, it can be also argued that the case company investigated represents an exception, in its attempt to formally treat environmental performance measures within their management control systems by adopting a "shared ownership" between accounting and environmental functions across the organization. However, as a general trend, I believe that EMA will progressively move towards a more central position in the accounting field, particularly as a result of isomorphic pressures that are emerging at institutional level. EMA is not yet accepted as an accounting sub-discipline, but there are signals that the distance from the "core" of management accounting field will be progressively reduced in the future.

Apart from contextual limitations that makes problematic to study a phenomenon still in its development stage (cf. Choudhoury, 1988), methodological weaknesses affected the empirical studies of this dissertation. As I discussed in Section 5.5, a drawback of the survey design was the ineligibility of a significant portion of the respondents and the focus on companies from manufacturing sectors. An additional limitation referred to the development of measurement instruments in the area of environmental management and environmental accounting that were not previously validated. More importantly, the model specification about determinants and effects of environmental performance measures could be criticized for omitted variables. The predictor variables were endogenous choices, which tend to produce inconsistent parameter estimates. Case study design attempted to cope with the static research approach of the cross-sectional survey. Nevertheless, Section 6.6 emphasized as main limitations the interpretative approach of the case method and its inherent inability to provide generalizable findings since the case was conducted in a company that was representative of environmentally sensitive industries. Field observations were not compared with companies in other sector, or with companies having a more reactive approach towards environmental management.

The results and limitations of this study point to several directions for further theory-driven research around the topic of the use of environmental performance measures. I will concentrate on the topics that, in my opinion, require future attention by scholarly studies.

First, an important immediate issue requiring resolution is to establish criterion related validity of the construct and measurement instruments that can be applied to this field. In particular, considerable work is required to refine and validate an instrument that would adequately capture the variable *environmental strategy*. In this respect, the parallel drawn between quality management and environmental management can be taken as example to accomplish this objective. After two decades of research in quality management, rather established instruments underlying core conceptual dimensions of the practices involved in quality management are currently available and provide a useful point of departure for future validation in the environmental management field. Similarly, exploring the reliability and validity aspects of constructs like environmental performance and the informational attributes associated to environmental performance measures would contribute to the development of a more conclusive body of knowledge. It is evident from the review presented in Chapter 2 that such a validation process cannot be accomplished without cross-fertilizations among disciplines investigating the same area and a substantive amount of constructive replications.

Second, extending the conceptual model about the antecedents of environmental performance measures with additional contingency factors would be particularly fruitful. For instance, technological characteristics in the production process can be included in the nomological network. The empirical findings from the case study indicated that pollution prevention and control practices are strictly dependent upon the technological features embedded in the life cycle of a product. The focus on technology as contingency factor may lead to a better understanding of the level of sophistication of the environmental management information system. Differential effects can in fact be expected between, taken as extreme examples, production lines based on manual assembly operations versus highly automated transformation of commodity products. Technology can be also posited as explanatory variable of the informativeness properties associated to the environmental performance measures. It can be argued that sensitivity and precision of environmental indicators vary according to the ability of workers to influence input-output relationships embedded in the technological process. Furthermore, an extension of the model would include dimensions of environmental uncertainty to reflect important contextual and institutional determinants of EMA. The interpretation of the survey results already pointed at a misspecification of the instrument *precision of environmental performance measures* that apparently captured uncertainty elements surrounding the management of environmental-related activities. The measurement instrument developed by Lewis and Harvey (2001), that attempted to translate the concept of *perceived environmental uncertainty* in the field of environmental management, can be readily applied for further questionnaire-based studies. In addition, it is important to include in the analysis structural aspects of organizational design, in line with recent studies in management accounting about the linkages between decentralization of decision-making and performance measure characteristics (cf. Abernethy and Lillis, 2001; Nagar, 2002; Moers, 2004). A more detailed understanding of the relationships between structural elements of environmental management and performance measurement systems would also contribute to the limited amount of managerial and organizational studies focused on this topic.

Third, I see opportunities to investigate the behavioral effects associated with the use of environmental performance measures. It was evident from the case study that informational attributes of environmental performance measurement systems induced different reactions in the systems’ users. It would be particularly interesting to analyze individual-level consequences of performance measurement choice in situations where environmental metrics and targets are formally introduced in performance evaluation and incentive schemes. Insights from *goal theory*, *expectancy theory* and *procedural justice* literature in organizational psychology could be applied to conceptualize and test consequences of environmental performance measurement systems on employees’ motivation. In combination, field-based research might enhance our understanding about functional and dysfunctional effects attached to environmental performance measures. I also believe that these measures could be employed as a specific category of performance measures to address the effects of incentive schemes in multi-tasking setting. From the discussion presented in previous chapters, environmental metrics indeed present peculiar features (i.e. lack of controllability, potential distortion and limited verifiability for some hard-to-measure environmental aspects) that are particularly suitable to be further investigated in a laboratory setting. It is advisable to extend the analysis about environmental performance measures alone to a combination of non-financials and financials performance indicators. This line of research would contribute to experimental research in management accounting that investigates design and effects of performance measurement choice (cf. Sprinkle, 2003 for a review).

Further research is also needed concerning the role of accountants and controllers as key organizational agents to understand *processual* aspects associated with the implementation – or lack thereof – of environmental accounting practices. In many respects, the area seems suitable to explore organizational change process and its effects on the integration of financial and operational realities in management accounting and control (cf. Hopwood, 1978, Luft and Shields, 2003). The case study illustrates that future research on EMA adoption should therefore move beyond pure cross-sectional studies and encompass the entire implementation process.

Finally, a broad limitation of the two empirical studies presented in this dissertation refers to their geographical scope. Provided that a combination of organizational and contextual factors appears to have a strong influence on the practical evolution of the object of study, EMA may well exhibit different patterns across countries than the ones presented here. For instance, legal and economic factors might exert dissimilar influences on EMA adoption in European versus North American companies. The case observation indicates that, among other factors, unionization and contractual aspects of compensation systems appear as explanatory factors of performance measurement choice (cf. Ittner and Larcker, 2002). As another example, the diversity that characterizes Anglo-American versus Germanic approaches in the area of corporate governance is also likely to generate differential effects on environmental management and corporate social responsibility (see Habisch, Jonker, Wegner and Schmidpeter, 2005). It would be fruitful to investigate how these changes at macro-level will affect the diffusion of EMA in different regulatory frameworks, both in terms of speed and extent of adoption. Furthermore, cultural aspects may play a different role, as illustrated by the stream of studies that investigates the relationship between national cultures and control systems in management accounting research (see Chow, Shields and Wu, 1999; Harrison and McKinnon, 1999). Comparative studies carried out in multinationals would particularly contribute to our knowledge about the interplay between (national and organizational) cultures and performance measurement choice in this area (Baskerville, 2003; Van der Stede, 2003; Baskerville-Morley, 2005).

APPENDICES

APPENDIX A – Review of measurement instruments of environmental strategy

Table A.1 – Representative studies that developed measurement instruments of *environmental strategy*

Study (academic field) [a)]	**Label**	**Level of analysis**	**Typologies of environmental management**	**No. items (retained)**	**Factors (coefficient Alpha)**	**Factor extraction method** [b)]	**Sample size**
Levy (1995) (1)	Environmental policies and procedures	Company (corporate and plant level)	No typology	47 (47)	Not reported	EFA not performed	$n = 80$
Vastag, Kerekes and Rondinelli (1996) (2)	Corporate environmental management	Company (corporate and plant level)	*Reactive*, *crisis preventive*, *strategic*, *proactive*	16 (16)	1. General environmental attitude ($\alpha = 0.64$); 2. Key environmental concerns within the industry ($\alpha = 0.72$); 3. Seriousness of environmental issues ($\alpha = 0.73$)	EFA not performed	$n = 169$
Aragon-Correa (1998) (1)	Natural environmental management	Corporate level	*Environmental excellence*, *Leading edge*, *Compliance*, *Compliance plus*, *Noncompliance*	14 (14)	1. Information and education (not reported); 2. Traditional/Regulated correction (not reported); 3. Modern/Voluntary prevention (not reported)	Orthogonal (Varimax)	$n = 99$
Judge and Douglas (1998) (1)	Environmental issues integration	Corporate and divisional level	*Not-integrated* versus *integrated* incorporation of environmental issues in strategic planning	5 (5)	One factor (not reported)	CFA with Structural equation model (LISREL)	$n = 196$
Klassen and Angel (1998) (2)	Environmental management posture	Plant level	*Opportunistic*, *Reactive*, *Proactive*, *Compliance posture*	9 (8)	1. Environmental ambition (not reported); 2. Regulatory-driven motivation (not reported)	Orthogonal (Varimax)	$n = 218$

Table A.1 (continued)

Study (academic field) [a)]	**Label**	**Level of analysis**	**Typologies of environmental management**	**No. items (retained)**	**Factors (coefficient Alpha)**	**Factor extraction method** [b)]	**Sample size**
Henriques and Sadorsky (1999) (1)	Environmental commitment	Corporate level	*Reactive*, *Defensive*, *Accommodating*, *Proactive*	6 (6)	Not reported	EFA not performed	n = 400
Sharma and Vredenburg (1998) (1)	Proactive environmental strategy	Company (corporate and plant level)	*Reactive* versus *Proactive* environmental strategies	95 (95)	10 unidimensional factors (overall α = 0.84)	Not indicated	n = 99
Klassen and Whybark (1999); Klassen (2001) (2)	Environmental management orientation	Plant level	*Reactive* versus *Proactive* environmental management orientation	19 (15)	1. Systems analysis and planning (α = 0.79); 2. Organizational responsibility (α = 0.74); 3. Management controls factors (α = 0.89)	CFA with Structural equation model (SAS)	n = 83
Christmann (2000) (1)	Environmental strategies	Business unit level	Best practices of environmental management	8 (8)	1. Pollution prevention (α = 0.70); 2. Innovation of proprietary pollution (α = 0.78); 3. Timing environmental management (α = 0.91)	EFA not performed	n = 88
Winn and Angell (2000) (1)	Corporate greening	Corporate level	*Deliberate reactive greening*, *Unrealized greening*, *Emergent active greening*, *Deliberate proactive greening*	24 (12)	1. Approach to environmental management (α = 0.82); 2. Policy commitment to environmental issues (α = 0.79)	Orthogonal (Varimax)	n = 135
Nakamura, Takahashi and Vertinsky (2001) (4)	Firm's environmental commitments	Company (corporate and plant level)	*Low* versus *High environmental commitments*	16 (16)	1. Environmental policy formulation (not reported); 2. Environmental policy integration (not reported)	Orthogonal (Varimax)	n = 193

Table A.1 (continued)

Study (academic field) [a]	**Label**	**Level of analysis**	**Typologies of environmental management**	**No. items (retained)**	**Factors (coefficient Alpha)**	**Factor extraction method** [b]	**Sample size**
Sharma (2001) (1)	Environmental strategy	Company (corporate and plant level)	*Reactive* versus *Proactive* environmental strategies	54 (54)	7 unidimensional factors (overall α = 0.87)	Orthogonal (Varimax)	*n* = 99
Banerjee (2002) (3)	Corporate environmentalism	Company (corporate and business unit level)	*Environmental orientation* (low versus high); *Environmental strategy focus* (not integrated versus integrated into strategic planning)	22 (8); 23 (8)	1. Environmental orientation (Internal orientation α = 0.89; External orientation α = 0.73) 2. Environmental strategy focus (Corporate α = 0.90; Business unit α = 0.86)	EFA + CFA with Structural equation model	*n* = 311
Banerjee, Iyer and Kashyap (2003) (3)	Corporate environmentalism	Company (corporate and business unit level)	*Environmental orientation* (low versus high); *Environmental strategy focus* (not integrated versus integrated into strategic planning)	13 (8); 7 (4)	1. Environmental orientation (not reported) 2. Environmental strategy focus (not reported)	CFA with Structural equation model	*n* = 243
Buysse and Verbeke (2003) (1)	Environmental strategies	Corporate level	*Reactive strategy*, *Pollution prevention*, *Environmental leadership*	10 (10)	1. Green competencies; 2. Employee skills; 3. Management systems and procedures; 4 Strategic planning process	EFA not performed	*n* =197
Melnyk, Sroufe and Calantone (2003) (2)	Environmental management system	Plant level	Status of environmental management systems	16 (16)	One factor (not reported)	EFA not reported	*n* = 1,510

Table A.1 (continued)

Study (academic field) [a]	**Label**	**Level of analysis**	**Typologies of environmental management**	**No. items (retained)**	**Factors (coefficient Alpha)**	**Factor extraction method** [b]	**Sample size**
Aragon-Correa, Matias-Reche and Senise-Bario (2004) (1)	Environmental commitment	Corporate level	*Low* versus *high environmental commitment*	14 (14)	One factor ($\alpha = 0.91$)	EFA not reported	$n = 112$
Menguc and Ozanne (2005) (1)	Commitment to the natural environment	Corporate level	No typology	9 (9)	One factor ($\alpha = 0.93$)	CFA with structural equation model	$n = 140$

Note: contents and structure of the table are adapted from Gil, Jimenez and Lorente (2001) and Kolk and Mauser (2002).
[a] The academic fields are classified as follows: (1) strategic management or general management; (2) operations management; (3) marketing; (4) environmental economics.
[b] EFA: exploratory factor analysis; CFA: confirmatory factor analysis.

APPENDIX B – Empirical literature about the link operational strategies – MCS

Table B.1 – Outline of representative studies on the link between operational strategies and management accounting and control systems

Study	**Operational Strategies**	**MCS elements**	**Dependent Variables** ***Statistical model***	**Sample (No. of organizations)** ***Data source***	**Main findings**
Daniel and Reitsperger (1991)	Quality strategy (ECL versus "zero defect" strategy)	Quality goal setting Quality feedback	None *Correlation study between operational strategy and MCS*	459 manufacturing firms (26 Japanese consumer electronics and automotive manufacturers) *Mail survey*	MCS supporting a "zero defect" quality strategy are more likely to include regular goal-setting and more frequent feedback relating to quality than those quality strategy supporting an ECL quality strategy.
Banker, Potter and Schroeder (1993)	JIT TQM Team Decentralization		Availability of non-financial information to workers (5 variables) Worker morale *OLS regressions* *Logit regressions*	362 individual workers (40 US manufacturing plants) *Mail survey*	The operational strategies exhibit strong positive association with the likelihood that information on quality and productivity is provided to workers. The statistical significance of the single coefficients vary by type of information. Strong positive relationship is also found between worker morale and operational strategies.
Wruck and Jensen (1994)	TQM	Allocation of decision rights Performance measurement Performance evaluation ("organizational architecture")	Qualitative case study	Sterling Chemicals, Inc. *Semi-structured interviews*	Taking an economic and organizational perspective, two key principles that lie behind effective TQM programs are identified: a) the effective use of science in everyday decision-making by employees at all levels of the organization, and b) major changes in the three components of the organizational architecture (decentralization of decision rights, the adoption of new performance measures, and the implementation of new reward systems).

Table B.1 (continued)

Study	**Operational Strategies**	**MCS elements**	**Dependent Variables** ***Statistical model***	**Sample (No. of organizations)** ***Data source***	**Main findings**
Abernethy and Lillis (1995)	Manufacturing flexibility	Integrative liaison devices Efficiency-based performance measures (use for decision-making)	Performance (relative to competitors) *Correlation*	42 business units in Australia *Semi-structured interviews*	Firms committed to flexibility use integrative liaison devices to a significantly greater extent and rely on efficiency-based measures to a significantly lesser extent. The correlations between performance and use of efficiency-based measures were in the predicted direction (positive for the non-flexible firms, negative for the flexible firms).
Daniel, Reitsperger and Gregson (1995)	Socialization and Size → Quality strategy	Quality goal setting Quality feedback	Expected reward *Structural equation models (Japan versus US)*	1,487 manufacturing firms (698 from 50 Japanese firms and 789 from 64 US firms) *Mail survey*	In both Japan and US, quality strategy is significantly linked to the managers' expectation of reward for achieving quality goals. A greater association between quality strategy and reward systems is found in the US than Japan.
Ittner and Larcker (1995)	TQM	Non-traditional performance and reward systems	Organizational performance *Canonical correlation*	249 organizations in automotive and computer sector (Canada, Germany, United States and Japan) *Computer survey*	TQM practices are related to non-traditional MCS that place greater emphasis on team and non-financial performance, more frequent provision of quality information and greater use of bottom-up data gathering techniques. No support is found to the proposition that non-traditional MCS improve the performance of organizations with extensive quality programs.
Selto, Renner and Young (1995)	Joint TQM/JIT	Worker authority Vertical communication Horizontal communication	Workgroup effectiveness Job satisfaction *Contingency tests (selection, interaction and systems type of fit)*	406 workers and 19 managers in a division of manufacturing company *Archival/field survey*	The simpler selection approach is more effective in explaining variation in workgroup effectiveness. The implementation of TQM/JIT is not supported by empowerment mechanism, with a negative effect on job satisfaction.

Table B.1 (continued)

Study	**Operational Strategies**	**MCS elements**	**Dependent Variables** ***Statistical model***	**Sample (No. of organizations)** ***Data source***	**Main findings**
Carr, Mak and Needham (1997)	TQM (ISO 9000)	Performance reporting frequency of quality measures	None *t-test of differences between ISO and non-ISO certified companies*	107 manufacturing firms in New Zealand *Mail survey*	Some support is provided that companies certified ISO provide more frequent physical quality measures than non-ISO certified companies. No support is found for hypotheses on differences in use of financial quality and traditional performance measures between the two groups of companies.
Chenhall (1997)	TQM	Reliance on manufacturing performance measures	Organizational profitability OLS moderated regression	39 manufacturing firms in Australia *Mail survey*	Higher performance is associated with the combination of TQM and a reliance on manufacturing performance measures compared to TQM without such measures.
Ittner and Larcker (1997)	Quality management (4 items)	Internal monitoring practices (3 variables) External monitoring practices (3 variables)	None *Correlations across countries*	249 organizations in automotive and computer sector (Canada, Germany, United States and Japan) *Computer survey*	Organizations placing greater emphasis on quality in their strategic plans tend to make greater use of quality-related strategic control practices. Japanese companies appear to make greater use of many of the strategic control practices regardless of their organization's strategic emphasis. Several strategic control systems are negatively associated with performance, consistent with claims that formal control systems hinder flexibility and creativity.
Perera, Harrison and Poole (1997)	Advanced manufacturing practices (AMP) Advanced manufacturing technology (AMT)	Use of non-financial performance measures	Performance (self-rated) *OLS moderated regression*	109 manufacturing firms/divisions in Australia *Mail survey*	Replication of study by Abernethy and Lillis (1995). There is a greater emphasis on non-financial performance measures for firms in which both AMP and AMT are high. No support is found for the argument that the use of non-financials is associated with enhanced performance for firms pursuing a customer-focused strategy.

Table B.1 (continued)

Study	**Operational Strategies**	**MCS elements**	**Dependent Variables** ***Statistical model***	**Sample (No. of organizations)** ***Data source***	**Main findings**
Sim and Killough (1998)	Joint TQM/JIT	Performance goals Performance measures Performance-contingent rewards	Performance *OLS moderated regression*	83 manufacturing plants in US *Mail survey*	Performance gains from complementarities (synergies) result from combining TQM or JIT along with performance goals. No evidence that performance is an interactive function of production systems and performance measures is found. Findings also indicate that higher performance can be achieved when TQM or JIT practices are used along with performance-contingent incentive plans. Finally, management accounting systems that have incentive pay and more extensive performance goals, coupled with high levels of TQM or JIT, result in the highest level of performance.
Fullerton and McWatters (2002)	JIT (3 variables)	Performance measures and incentive systems (10 variables)	None *OLS hierarchical regression*	253 US manufacturing firms *Mail survey*	The use of non-traditional performance measures (e.g. bottom-up measures, product quality, and vendor quality), as well as the use of incentive systems of employee empowerment and compensation rewards for quality production, is related to the degree of JIT practices implemented.

APPENDIX C

Measurement instruments and items analysis

Table C.1 through C.9 below summarize items and results of the instruments included in the questionnaire. Each table contains the English version of the introductory questions and the items in the instrument. Items that are reversely coded contain the symbol (R). Items that were eventually dropped are indicated with an asterisk (*). I summarize mean and standard deviation per item to allow some descriptive analysis. Some statistics concerning reliability and validity of the measures are then presented. The reliability analysis consists of the Cronbach's coefficient Alpha (α), the item-total correlation (range) and the inter-item-correlation (range) after having corrected for the items that were eventually dropped. The validity of the instruments is evaluated on the basis of exploratory factor analysis, relying upon principal component as factor-extraction procedure. I report evidence of unidimensionality for each instrument. Following the indications of Fabrigar *et al.* (1999) and Conway and Huffcut (2003), the statistics indicate the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy, the Bartlett's test of Sphericity, the communalities and the percentage of variance explained. I perform orthogonal or oblique rotation for combinations of instruments to show discriminant validity among instruments that are expected to share common variance. This item analysis will be complemented by the PLS measurement model presented in Chapter 5 (Section 5.2.2).

APPENDIX C

Table C.1 – Environmental strategy (ENV_STR)

To what extent do you agree with the following statements concerning the integration of the environmental policy in the general business policy of your company? [a]		Mean	s.d.	% [b]
ENV_STR1	My company has a clear policy statement urging environmental awareness in every area	3.16	1.44	50.6
ENV_STR2	My company has integrated environmental issues in the formal strategic planning process	2.81	1.35	38.0
ENV_STR3	The top-management of my company gives environmental issues a high priority	3.12	1.28	43.0
ENV_STR4	Environmental concerns within my company are primarily driven by regulatory requirements (R)*	2.31	0.94	63.3
ENV_STR5	In my company “quality” includes reducing the unit’s environmental impact	3.45	0.93	51.9
ENV_STR6	In my company environmental goals are linked with other corporate goals	3.18	1.90	44.3
ENV_STR7	Customers complaints and suggestions about environmental aspects of my company’s products are used to evaluate my company’s performance*	3.34	1.00	51.9
ENV_STR8	My company is engaged in designing processes and products that minimize environmental impact*	3.27	1.19	48.7
ENV_STR9	My company has a responsibility to preserve the natural environment*	4.03	1.00	81.0
ENV_STR10	Environmental issues, policies and procedures are included in formal training programs for my unit’s employees	2.87	1.24	37.2
ENV_STR11	My unit implements employee involvement type programs (e.g. like quality circles or suggestion programs) that explicitly include environmental management aspects	2.72	1.20	32.1
ENV_STR12	Information on environmental performance is widely distributed to employees	2.63	1.23	25.6
ENV_STR13	Employees from a variety of areas (R&D, operations, marketing, accounting) work in interdepartmental task-forces to modify product and process design in response to environmental problems	2.39	1.10	44.9
ENV_STR14	There is a formal reporting position between those responsible for environmental affairs within my organizational unit and company’s senior executives	3.27	1.28	54.4
ENV_STR15	Standardized and documented operating procedures about environmental management are in place	3.32	1.27	48.7
ENV_STR16	Documented operating procedures about environmental management are made clear to all employees	2.94	1.15	33.3
ENV_STR17	Temporary task-forces or workgroups are formed to solve problems related to environmental aspects of my organizational unit	3.01	1.24	46.2
ENV_STR18	Standardized procedures are in place to include environmental aspects in capital expenditure decisions	2.84	1.23	33.3
ENV_STR19	My unit engages in a continuous dialogue with local communities and environmental organizations with regards to the environmental aspects of processes and products	3.02	1.43	47.4

Table C.1 (continued)

To what extent do you agree with the following statements concerning the integration of the environmental policy in the general business policy of your company? [a]		Mean	s.d.	% [b]
ENV_STR20	Employees from a variety of areas (R&D, operations, marketing, accounting) coordinate environmental-related activities by spontaneous contact	2.09	0.86	32.1
ENV_STR21	The environmental performance of my organizational unit is periodically evaluated by an internal audit	2.53	1.43	28.2

Notes: sample size n = 77.
[a] Answering format: 1= *completely disagree*; 2= *disagree;* 3= *neither disagree nor agree*; 4= *agree*; 5= *completely agree*.
[b] Cumulative percentage of answers scoring 4= *agree* and 5= *completely agree.*

Item-analysis

Reliability analysis:	ENV_STR	ENV_STR (principles)	ENV_STR (practices)
Cronbach's Alpha	α = 0.967	α = 0.894	α = 0.959
Item-to-total correlation (range)	0.606 – 0.856	0.637 – 0.862	0.695 – 0.858
Intra-item-correlation (range)	0.366 – 0.851	0.318 – 0.832	0.484 – 0.856
Validity analysis:			
Factor extraction method	Principal component	Principal component	Principal component
KMO Measure	0.942	0.843	0.945
Bartlett's Test (p-value)	1.2 (p<0.001)	294.6 (p<0.001)	822.2 (p<0.001)
Communalities (range)	0.411 – 0.774	0.403 – 0.834	0.549 – 0.781
Variance accounted for	66.4%	65.6%	69.7%

APPENDIX C

Component matrix

	Component
	1
ENV_STR1	0.817
ENV_STR2	0.875
ENV_STR3	0.812
ENV_STR5	0.641
ENV_STR6	0.768
ENV_STR10	0.822
ENV_STR11	0.880
ENV_STR12	0.870
ENV_STR13	0.720
ENV_STR14	0.865
ENV_STR15	0.867
ENV_STR16	0.828
ENV_STR17	0.813
ENV_STR18	0.813
ENV_STR19	0.780
ENV_STR20	0.822
ENV_STR21	0.826
Eigenvalue	11.3
Variance explained	66.4%

Extraction method: Principal component analysis
Rotation method: Orthogonal (Varimax)
Reported factor loadings above 0.40

Table C.2 – Availability of environmental performance measurement system (EMIS_AVA)

We wish to know the extent to which environmental performance measures – non-financial and financial - are explicitly generated and reported in your unit. [a]		Mean	s.d.	% [b]
EMIS_AVA1	Non-financial Resource measures	1.36	3.09	43.2
EMIS_AVA2	Non-financial Output measures	1.58	3.09	45.7
EMIS_AVA3	Non-financial Efficiency measures	1.37	3.06	48.1
EMIS_AVA4	Non-financial Impact/Risk measures	1.58	2.99	45.7
EMIS_AVA5	Non-financial Management measures	1.35	2.43	29.6
EMIS_AVA6	Financial Resource measures	1.16	3.25	44.4
EMIS_AVA7	Financial Output measures	1.30	2.81	33.3
EMIS_AVA8	Financial Efficiency measures	1.32	3.07	43.2
EMIS_AVA9	Financial Impact/Risk measures	1.21	2.78	32.1
EMIS_AVA10	Financial Management measures	1.19	2.54	24.7

Notes: sample size n = 77.
[a] Answering format: 1= *very small extent*; 2= *small extent;* 3= *moderate extent*; 4= *great extent*; 5= *very great extent*.
[b] Cumulative percentage of answers scoring 4= *great extent* and 5= *very great extent.*

Item-analysis

Reliability analysis:	
Cronbach's Alpha	α = 0.939
Item-to-total correlation (range)	0.661 – 0.853
Intra-item-correlation (range)	0.384 – 0.824
Validity analysis:	
Factor extraction method	Principal component
KMO Measure	0.842
Bartlett's Test (p-value)	706.8 (p<0.001)
Communalities (range)	0.719 – 0.886
Variance accounted for	64.8%

APPENDIX C

Component matrix

	Component
	1
EMIS_AVA1	0.821
EMIS_AVA2	0.886
EMIS_AVA3	0.746
EMIS_AVA4	0.858
EMIS_AVA5	0.830
EMIS_AVA6	0.770
EMIS_AVA7	0.807
EMIS_AVA8	0.719
EMIS_AVA9	0.794
EMIS_AVA10	0.803
Eigenvalue	6.5
Variance explained	64.8%

Extraction method: Principal component analysis
Rotation method: no rotation
Reported factor loadings above 0.40

Table C.3 – Scope (EMIS_SCO) and timeliness (EMIS_TIM) of environmental management information system

To what extent do you agree with the following statements related to the environmental information system within your organizational unit? [a]		Mean	s.d.	% [b]
EMIS_SCO1	Information that relates to possible future events is available (for example new environmental regulation)	3.19	1.20	50.6
EMIS_SCO2	Environmentally-related information on broad factors external to my organization is tracked and monitored (e.g. technological developments. best-in-class environmental performance in your industry)	3.14	1.27	46.9
EMIS_SCO3	The likelihood of future events (e.g. environmental risk assessment) is quantified	3.27	1.25	56.8
EMIS_TIM1	Environmental information is provided on a systematic and regular basis	3.00	1.38	39.5
EMIS_TIM2	There is no delay between the occurring of an event that affects environmental performance and relevant information being reported	3.49	1.34	64.2

Notes: sample size n = 81.
[a] Answering format: 1= *completely disagree*; 2= *disagree;* 3= *neither disagree nor agree*; 4= *agree*; 5= *completely agree*.
[b] Cumulative percentage of answers scoring 4= *agree* and 5= *completely agree.*

Item-analysis

Reliability analysis:	EMIS_SCO	EMIS_TIM
Cronbach's Alpha	α = 0.849	α = 0.896
Item-to-total correlation (range)	0.675 – 0.779	0.812
Intra-item-correlation (range)	0.573 – 0.707	0.812
Validity analysis (test of unidimensionality):		
Factor extraction method	Principal component	Principal component
KMO Measure	0.708	0.500
Bartlett's Test (p-value)	104.2 (p<0.001)	84.5 (p<0.001)
Communalities (range)	0.724 – 0.828	0.906
Variance explained	76.8%	90.6%

Rotated component matrix EMIS_SCO and EMIS_TIM with 2 factors imposed

	Component	
	1	2
EMIS_SCO1		0.927
EMIS_SCO2	0.711	0.529
EMIS_SCO3	0.874	
EMIS_TIM1	0.851	
EMIS_TIM2	0.687	0.570
Eigenvalue	3.8	0.5
Variance extracted	75.3%	9.2%

Extraction method: Principal component analysis
Rotation method: orthogonal (Varimax)
Reported factor loadings above 0.40.

APPENDIX C

Table C.4 – Accuracy of environmental management information system (EMIS_ACC)

To what extent do you agree with the following statements related to the environmental information system within your organizational unit? [a]		Mean	s.d.	% [b]
EMIS_ACC1	The information about environmental performance is collected or estimated with objective measurement methods	3.00	1.30	42.0
EMIS_ACC2	The measurement of environmental performance is accurate	3.21	1.23	46.9
EMIS_ACC3	The information about environmental performance is difficult to manipulate	2.85	1.06	25.9
EMIS_ACC4	An independent person verifies the measurement of environmental performance	2.62	1.37	33.3

Notes: sample size $n = 81$.
[a] Answering format: 1= *completely disagree*; 2= *disagree;* 3= *neither disagree nor agree*; 4= *agree*; 5= *completely agree*.
[b] Cumulative percentage of answers scoring 4= *agree* and 5= *completely agree.*

Item-analysis

Reliability analysis:	
Cronbach's Alpha	$\alpha = 0.868$
Item-to-total correlation (range)	0.607 – 0.852
Intra-item-correlation (range)	0.452 – 0.833
Validity analysis (test of unidimensionality):	
Factor extraction method	Principal component
KMO Measure	0.776
Bartlett's Test (p-value)	180.0 (p<0.001)
Communalities (range)	0.586 – 0.866
Variance accounted for	72.2%

Component matrix

	Component
	1
EMIS_ACC1	0.894
EMIS_ACC2	0.930
EMIS_ACC3	0.765
EMIS_ACC4	0.799
Eigenvalue	2.9
Variance explained	72.2%

Extraction method: Principal component analysis
Rotation method: no rotation
Reported factor loadings above 0.40

Table C.5 – Sensitivity of environmental performance measures (EPM_SEN)

To what extent do you agree with the following statements related to environmental performance measures? [a]		Mean	s.d.	% [b]
EPM_SEN1	If my organizational unit functions well, it is directly reflected in better environmental performance	1.23	2.67	29.6
EPM_SEN2	Working hard in my organizational unit leads to better environmental performance	0.92	2.26	38.3
EPM_SEN3	Performance expressed in environmental measures reflects the talent and the expertise of the personnel working in my organizational unit	1.19	3.32	54.3
EPM_SEN4	The environmental performance measures in my unit provide me with information about environmental performance that I <u>cannot</u> get from performance measures that are not environmental-related	1.14	3.14	43.2
EPM_SEN5	It is not possible to distinguish the effects produced by activities carried out to improve environmental performance from the effects caused by activities carried out for other purposes (R)*	1.03	3.25	27.2

Notes: sample size *n* = 81.
[a] Answering format: 1= *completely disagree*; 2= *disagree;* 3= *neither disagree nor agree*; 4= *agree*; 5= *completely agree*.
[b] Cumulative percentage of answers scoring 4= *agree* and 5= *completely agree.*

Table C.6 – Precision of environmental performance measures (EPM_PRE)

To what extent have the following external factors an influence on environmental performance expressed in the environmental measures of your organizational unit? [a]		Mean	s.d.	% [b]
EPM_PRE1	Changes in environmental regulation (R)	1.09	2.36	58.8
EPM_PRE2	Changes in the economic conditions (R)	0.94	3.29	22.5
EPM_PRE3	Changes in the behavior of customers (R)	1.19	2.85	48.8
EPM_PRE4	Changes in the behavior or strategies of suppliers (R)	1.02	3.11	28.8
EPM_PRE5	Changes in the behavior or strategies of competitors (R)	1.05	3.14	28.8
EPM_PRE6	Changes in manufacturing technology (R)	0.94	2.44	57.5

Notes: sample size *n* = 81.
[a] Answering format: 1= *very small extent*; 2= *small extent;* 3= *moderate extent*; 4= *great extent*; 5= *very great extent*.
[b] Cumulative percentage of answers scoring 4= *great extent* and 5= *very great extent.*

APPENDIX C

Item-analysis

Reliability analysis:	EPM_SEN	EPM_PRE
Cronbach's Alpha	α = 0.745	α = 0.826
Item-to-total correlation (range)	0.221 – 0.655	0.438 – 0.677
Intra-item-correlation (range)	0.431 – 0.629	0.176 – 0.612
Validity analysis (test of unidimensionality):		
Factor extraction method	Principal component	Principal component
KMO Measure	0.649	0.764
Bartlett's Test (*p*-value)	93.8 (p<0.001)	173.8 (p<0.001)
Communalities (range)	0.409 – 0.612	0.337 – 0.646
Variance accounted for	46.0%	54.2%

Pattern matrix with 2 factors imposed

	Component	
	1	2
EPM_SEN1		0.627
EPM_SEN2		0.704
EPM_SEN3		0.823
EPM_SEN4		0.757
EPM_PRE1		-0.434
EPM_PRE2	0.761	
EPM_PRE3	0.819	
EPM_PRE4	0.759	
EPM_PRE5	0.830	
EPM_PRE6	0.621	
Eigenvalue	4.1	1.6
Variance extracted	40.9%	16.0%

Extraction method: Principal component analysis
Rotation method: Oblique (Oblimin)
Reported factor loadings above 0.40

Table C.7 – Congruity of environmental performance measures (EPM_CON)

To what extent do you agree with the following statements? [a]		Mean	s.d.	% [b]
EPM_CON1	My unit is pressured to maintain a high level of productivity and generate short-term profits and therefore it is difficult to improve environmental performance (R)*	1.06	3.48	19.8
EPM_CON2	An improvement in environmental performance measures leads to an improvement in the long-term value of my firm	1.16	3.38	56.8
EPM_CON3	The occurrence of an environmental accident causes immediate negative consequences on the financial performance of my company	1.23	3.27	50.6
EPM_CON4	The financial performance of my organizational unit does not depend on its environmental performance (R)	1.23	2.89	43.2
EPM_CON5	In my organizational unit there is consensus among various departments (R&D, operations, marketing, accounting) when it comes to deciding which actions should be taken to improve environmental performance*	1.09	2.36	34.6

Notes: sample size n = 81.
[a] Answering format: 1= *completely disagree*; 2= *disagree;* 3= *neither disagree nor agree*; 4= *agree*; 5= *completely agree*.
[b] Cumulative percentage of answers scoring 4= *agree* and 5= *completely agree.*

Item-analysis

Reliability analysis:	
Cronbach's Alpha	α = 0.748
Item-to-total correlation (range)	0.542 – 0.563
Intra-item-correlation (range)	0.437 – 0.542
Validity analysis (test of unidimensionality):	
Factor extraction method	Principal component
KMO Measure	0.680
Bartlett's Test of Sphericity (*p*-value)	54.8 (p<0.001)
Communalities (range)	0.625
Variance accounted for	71.7

Component matrix

	Component
	1
EPM_CON2	0.808
EPM_CON3	0.791
EPM_CON4	0.847
Eigenvalue	2.0
Variance explained	71.7%

Extraction method: Principal component analysis
Rotation method: no rotation
Reported factor loadings above 0.40

Table C.8 – Use of environmental performance measures (USE_EPM)

Can you indicate how much importance is attributed to the environmental performance measures available in your organizational unit (both expressed in non-financial and financial terms) for each of the following objectives? [a]		Mean	s.d.	% [c]
Use for decision-control (USE_EPM_DC) [b]				
USE_EPM_DC1	The periodic evaluation of my organizational unit's performance	3.48	2.05	22.2
USE_EPM_DC2	Determining salary increases of my organizational unit's personnel	2.41	1.82	9.9
USE_EPM_DC3	Determining annual bonus of my organizational unit's personnel	2.48	1.73	6.2
USE_EPM_DC4	Increasing the chances of promotion of my organizational unit's personnel	2.27	1.52	9.9
USE_EPM_DC5	The evaluation of my unit's performance in comparison with the performance of other units	3.05	1.98	12.3
Use for decision-making (USE_EPM_DM) [b]				
USE_EPM_DM1	The daily management and operational decisions	3.49	1.80	17.3
USE_EPM_DM2	The selection and approval of capital expenditures	4.20	1.68	25.9
USE_EPM_DM3	The pricing of my unit's products and services	3.44	2.01	19.8
USE_EPM_DM4	The definition of standards for the selection/retention of external suppliers	3.49	1.77	14.8
USE_EPM_DM5	Assessing areas of potential cost-savings in the manufacturing process	4.14	1.78	30.9
Use for external accountability (USE_EPM_EXT)				
USE_EPM_EXT1	Preparing and issuing the corporate financial report	2.83	1.91	13.6
USE_EPM_EXT2	Preparing and issuing the corporate environmental report	3.70	2.44	34.6
USE_EPM_EXT3	Providing information to government officials for compliance to environmental legislation	4.67	1.85	39.5
USE_EPM_EXT4	Providing information to industrial associations for benchmarking	3.22	1.77	13.6
USE_EPM_EXT5	Providing information to local communities and non-governmental organizations	3.56	1.92	17.3

Notes: sample size n = 81.
[a] Answering format: from 1= *no important* to 7= *extremely important*
[b] The variables USE_EPM_DC and USE_EPM_DM are combined to form the variable USE_EPM_INT, which refers to the use of environmental performance measures for internal decision-making and control.
[c] Cumulative percentage of answers scoring 6= *very important* and 7= *extremely important.*

Item-analysis

Reliability analysis:	USE_EPM_INT	USE_EPM_EXT
Cronbach's Alpha	α = 0.956	α = 0.915
Item-to-total correlation (range)	0.738 – 0.874	0.724 – 0.839
Intra-item-correlation (range)	0.569 – 0.867	0.580 – 0.789
Validity analysis (test of unidimensionality):		
Factor extraction method	Principal component	Principal component
KMO Measure	0.929	0.859
Bartlett's Test (*p*-value)	795.9 (p<0.001)	284.9 (p<0.001)
Communalities (range)	0.619 – 0.817	0.667 – 0.814
Variance accounted for	72.4%	75.4%

Pattern matrix

	Component	
	1	2
USE_EPM_DC1	0.646	
USE_EPM_DC2	0.992	
USE_EPM_DC3	0.993	
USE_EPM_DC4	0.929	
USE_EPM_DC5	0.804	
USE_EPM_DM1	0.753	
USE_EPM_DM2	0.711	
USE_EPM_DM3	0.842	
USE_EPM_DM4	0.616	
USE_EPM_DM5	0.647	
USE_EPM_EXT1		0.837
USE_EPM_EXT2		0.891
USE_EPM_EXT3		0.928
USE_EPM_EXT4		0.639
USE_EPM_EXT5		0.714
Eigenvalue	9.7	1.5
Variance extracted	64.4%	10.2%

Extraction method: Principal component analysis
Rotation method: Oblique (Oblimin)
Reported factor loadings above 0.40

Pattern matrix with 3 factors imposed

	Component		
	1	2	3
USE_EPM_DC1			
USE_EPM_DC2	0.968		
USE_EPM_DC3	0.807		
USE_EPM_DC4	0.866		
USE_EPM_DC5	0.615		
USE_EPM_DM1			-0.576
USE_EPM_DM2			-0.855
USE_EPM_DM3			-0.789
USE_EPM_DM4			-0.673
USE_EPM_DM5			-0.852
USE_EPM_EXT1		0.872	
USE_EPM_EXT2		0.922	
USE_EPM_EXT3		0.834	
USE_EPM_EXT4		0.639	
USE_EPM_EXT5		0.608	-0.424
Eigenvalue	9.7	1.5	0.7
Variance extracted	64.4%	10.2%	4.9%

Extraction method: Principal component analysis
Rotation method: Oblique (Oblimin)
Reported factor loadings above 0.40

Table C.9 – Environmental performance (ENV_PER) and organizational performance (ORG_PER)

The use of the environmental performance measurement and management system within your organizational unit caused… [a]		Mean	s.d.	% [b]
Environmental performance (ENV_PER)				
ENV_PER1	…a reduction of costs of regulatory compliance	2.32	1.16	24.0
ENV_PER2	…a reduction of waste in the manufacturing process	3.00	1.32	45.9
ENV_PER3	...an improvement of the relationships with local communities and environmental groups	2.72	1.34	37.3
ENV_PER4	…an increased compliance with environmental regulations	3.31	1.33	54.7
ENV_PER5	...a mitigation of environmental risks	3.18	1.29	53.3
ENV_PER6	...an increased prevention of environmental accidents	3.15	1.27	54.7
Organizational performance (ORG_PER)				
ORG_PER1	…a reduction of overall production costs	2.04	1.06	32.0
ORG_PER2	…an improvement in product design and product development	2.38	1.05	17.3
ORG_PER3	…an improvement of product quality	2.35	1.07	49.3
ORG_PER4	…an improvement of the unit's market position in The Netherlands	1.81	0.97	6.8
ORG_PER5	…an improvement of the unit's market position on the international markets	1.82	0.99	21.9

Notes: sample size n = 74.
[a] Answering format: 1= *very small extent*; 2= *small extent;* 3= *moderate extent*; 4= *great extent*; 5= *very great extent*.
[b] Cumulative percentage of answers scoring 4= *great extent* and 5= *very great extent.*

Item-analysis

Reliability analysis:	ENV_PER	ORG_PER
Cronbach's Alpha	α = 0.914	α = 0.862
Item-to-total correlation (range)	0.633 – 0.886	0.464 – 0.767
Intra-item-correlation (range)	0.442 – 0.794	0.385 – 0.892
Validity analysis (test of unidimensionality):		
Factor extraction method	Principal component	Principal component
KMO Measure	0.848	0.720
Bartlett's Test (p-value)	341.2 (p<0.001)	231.2 (p<0.001)
Communalities (range)	0.532 – 0.867	0.359 – 0.775
Variance accounted for	70.4%	65.6%

Pattern matrix with 2 factors imposed

	Component	
	1	2
ENV_PER1	0.566	
ENV_PER2	0.515	
ENV_PER3	0.856	
ENV_PER4	0.960	
ENV_PER5	0.923	
ENV_PER6	0.908	
ORG_PER1		
ORG_PER2		0.712
ORG_PER3		0.728
ORG_PER4		0.975
ORG_PER5		0.623
Eigenvalue	6.8	1.6
Variance extracted	56.5%	13.5%

Extraction method: Principal component analysis
Rotation method: Oblique (Oblimin)
Reported factor loadings above 0.40

APPENDIX D

References on environmental performance measures (EPMs)

Table D.1 – References used to develop the instrument *availability* of EPMs

Study	Environmental costs (expressed in financial/monetary values)	Environmental performance measures (expressed in non-financial/physical values)
GEMI (1995)		*Example Procter & Gamble: Environmental Complexity Rating* ▪ Wastewater Discharges ▪ Soil and Groundwater Issues ▪ Air Emissions Sources ▪ Hazardous Waste Generation/Disposal ▪ Solid Waste Generation/Disposal ▪ Community Capabilities & Issues
Bennett and James (1998a) [a)]	Financial measures (of costs and benefits of environmental actions) (MPI)	▪ Resource measures (e.g. consumption of energy, water, and other resources) (OPI) ▪ Solid waste measures (OPI) ▪ Effluents to water measures (OPI) ▪ Emissions to air measures (OPI) ▪ Efficiency measures (e.g. material utilization) (OPI) ▪ Satisfaction measures (of customers, employees or stakeholders) (MPI) ▪ Impact measures (measures of ultimate environmental impact, e.g. BOD) (ECI) ▪ Risk indicators (ECI) ▪ Input/Process measures (e.g. hours training, % of sites with an EMS) (MPI)
IFAC (1998)	*External* environmental costs *Internal* environmental costs (Exhibit 2): ▪ Direct or Indirect environmental costs ▪ Contingent or Intangible environmental costs	
WBCSD (2000)	Additional Financial Value Indicators	**Environmental influence indicators**: ▪ Energy consumption ▪ Materials consumption ▪ Water consumption ▪ GHG Emissions ▪ Ozone Depleting Substances emissions

APPENDIX D

Table D.1 (continued)

Study	Environmental costs (expressed in financial/monetary values)	Environmental performance measures (expressed in non-financial/physical values)
United Nations (2001)	*Environmental protection costs*: include costs for prevention, disposal, planning, control, shifting actions and damage repair that can occur at companies and affect government and people Categories of environmental cost/expenditure: ▪ Waste and emission treatment ▪ Prevention and environmental management ▪ Material purchase value of non-product output ▪ Processing costs of non-product output	
Bristol-Myers Squibb Sustainability Report (2002)	*EHS Capital Expenditures:* EHS Expenses ▪ Direct expenses ▪ Waste treatment and Disposal Administrative expenses ▪ EHS Personnel ▪ Site-wide EHS training Remediations and Fines ▪ Ongoing remediation ▪ Spill cleanup ▪ Fines	▪ Materials ▪ Energy ▪ Water ▪ Biodiversity ▪ Emissions, effluents and waste ▪ Effluents to water ▪ Suppliers ▪ Products and Services ▪ Compliance activities ▪ Transport
Figge, Hahn, Schaltegger and Wagner (2002)	Monetary environmental information	Physical environmental information
UNCTAD/ISAR (2002)		▪ Water use ▪ Energy use ▪ Global warming contribution ▪ Ozone depleting substances ▪ Waste
GRI Global Reporting Initiative (2002)		*Environmental performance indicators:* ▪ Materials ▪ Energy ▪ Water ▪ Biodiversity ▪ Emissions, effluents, waste ▪ Suppliers ▪ Products and services ▪ Compliance ▪ Transport ▪ Overall

Table D.1 (continued)

Study	**Environmental costs (expressed in financial/monetary values)**	**Environmental performance measures (expressed in non-financial/physical values)**
Japan Ministry of Environment (2002)	*Environmental conservation cost:* ▪ Business area cost ▪ Upstream/downstream cost ▪ R&D cost ▪ Social activity cost ▪ Environmental remediation cost *Economic benefit associated with environmental conservation activities:* ▪ Actual benefit ▪ Estimated benefit	*Environmental conservation benefit* associated with: ▪ the inputs of resources into business operations ▪ environmental impact and waste emissions from business operations ▪ the goods and services produced by business operations ▪ transport and other operations
Sony Social and Environmental Report (2002)		*Environmental Performance Indices:* ▪ GHG targets ▪ Resource Input targets ▪ Resource Output targets ▪ Water Resource targets ▪ Hazardous Materials targets *Environmental Management Indices:* ▪ Corporate citizenship ▪ Environmental risk management ▪ Environmental education ▪ Environmental communication ▪ Environmental accounting

[a] ECI: Environmental Condition Indicators; OPI: Operational Performance Indicators; MPI: Management Performance Indicators

APPENDIX E
Survey descriptive statistics

Table E.1 – Response rate data

Response	**Frequency**	**Percent**	**Cumulative percent**
Usable returned questionnaires	81	28.4	28.4
Refused to participate (no time/no interest)	97	34.0	62.5
Not eligible (topic not applicable to company/function)	65	22.8	85.3
Not eligible (company policy)	4	1.4	86.7
New working place or retired	29	10.2	96.8
Not reachable (sickness, pregnancy or working abroad)	9	3.2	100.0
Total	285	100.0	

Table E.2 – Distribution of respondents among sectors

Sector	***Frequency***	***Percent***
Agriculture	2	2.5
Food products and beverages	10	12.3
Textiles, wearing apparels and leather	2	2.5
Wood	1	1.2
Publishing and printing	2	2.5
Coke and refined petroleum products	1	1.2
Chemicals	18	22.2
Rubber and plastics	1	1.2
Other non-metallic mineral products	2	2.5
Basic metals and fabricated metal products	9	11.1
Machinery and equipment	4	4.9
Electrical and optical equipment	6	7.4
Transport equipment	3	3.7
Furniture	3	3.7
Electricity, gas and hot water supply	1	1.2
Construction	11	13.6
Miscellaneous	5	6.2
Total	81	100.0

Table E.3 – Demographics

Variables	***Frequencies***
Sex	95% male
Age	38.4 years (mean), 6.8 years (s.d.)
Title	65.4% Registered Accountant (RA) 32.1% Registered Controller (RC) 2.5% both RA and RC
Function	65% Controller 28% Financial director/Financial manager 4% General manager 3% CFO
Tenure with organization	6.4 years (mean), 6.1 years (s.d.)
Tenure in function at current organization	3.2 years (mean), 2.6 years (s.d.)
Tenure in the same function	7.7 years (mean), 5.3 years (s.d.)
Position in line function	47%
Member of the organizational unit's management team	79%
Employees in area of responsibility	76.2 employees (mean), 339.3employees (s.d.)
Span of control	7.0 employees (mean), 7.0 employees (s.d.)
Influence on the design of performance measurement system [a)]	3.66 (mean), 0.99 (s.d.)
Influence on the design of incentive system [a)]	2.47 (mean), 1.14 (s.d.)

[a)] Answering format from 1= *no influence* to 5= *very much influence*.

Table E.4 – Sample characteristics

Variables	***Frequencies***
Level of analysis	34.6% corporate/firm level (*n* = 28) 32.1% divisional level (*n* = 26) 33.3% operational level (*n* = 27)
Size of the company	15,655 employees (mean), 25,331 (s.d.)
Size of the organizational unit	1,023 employees (mean), 2,118 (s.d.)
Subsidiary of a multinational	41.0%
Company listed in stock exchange	48.0%
Total Quality Management [a)]	2.80 (mean), 1.87 (s.d.)
Just In time [a)]	2.02 (mean), 1.97 (s.d.)
Flexible manufacturing systems [a)]	1.51 (mean), 1.68 (s.d.)
Computer Integrated Manufacturing [a)]	1.93 (mean), 1.93 (s.d.)
Manufacturing Resources Planning (MRP) [a)]	2.96 (mean), 1.98 (s.d.)
Real-time process control systems [a)]	2.35 (mean), 1.88 (s.d.)
Enterprise Resources Planning (ERP) [a)]	3.49 (mean), 1.78 (s.d.)
Activity-based costing [a)]	2.30 (mean), 1.57 (s.d.)
Balanced Scorecard [a)]	2.35 (mean), 1.69 (s.d.)
Value Based Management/EVA [a)]	2.15 (mean), 1.74 (s.d.)
Organizational unit certified ISO 9001	68.0% (*n* = 72)

[a)] Answering format: 0= *not applicable/no intention/not being considered*; 1= *assessing suitability*; 2= *beginning to implement*; 3= *partially implemented*; 4= *substantially implemented*; 5= *fully implemented*.

Table E.5 – Sample characteristics related to environmental management aspects

Variables	***Frequencies***
Environmental costs relative to total costs (2002)	3.3% (mean; *n* = 61)
Environmental investments relative to total investments (2002)	9.3% (mean; *n* = 61)
Presence of environmental department in the organizational unit	41.0%
Mandatory environmental reporting	29.6%
Integration of EMIS into accounting systems [a)]	2.12 (mean), 1.18 (s.d.)
Ownership of EMIS by controller's function [a)]	1.54 (mean), 0.84 (s.d.)
Organizational unit certified ISO 14001	40.0% (*n* = 53)

[a)] Answering format: 1= *completely disagree*; 2= *disagree;* 3= *neither disagree nor agree*; 4= *agree*; 5= *completely agree*.

Table E.6 – Descriptive statistics of variables

Variables	*Mean*	*s.d.*	*Theoretical range*		*Actual range*		*Skewness*	*Kurtosis*	*Test of normality*[a)]		*n*
			Min	*Max*	*Min*	*Max*			*Statistic*	*Sig.*	
1. ENV_STR	2.91	1.01	1.00	5.00	1.06	4.76	-0.680	-1.071	0.108	0.026	77
2. EMIS_AVA	2.91	1.08	1.00	5.00	1.00	5.00	-0.020	-1.151	0.125	0.003	81
3. EMIS_SCO	3.23	1.09	1.00	5.00	1.00	5.00	-0.629	-0.321	0.157	0.000	81
4. EMIS_TIM	3.25	1.30	1.00	5.00	1.00	5.00	-0.449	-0.870	0.133	0.001	81
5. EMIS_ACC	2.92	1.05	1.00	5.00	1.00	5.00	-0.291	-0.673	0.098	0.051	81
6. EPM_SEN	2.85	0.85	1.00	5.00	1.00	4.50	-0.484	0.068	0.146	0.000	81
7. EPM_PRE	2.86	0.76	1.00	5.00	1.00	5.00	0.700	0.809	0.155	0.000	80
8. EPM_CON	3.18	0.98	1.00	5.00	1.00	5.00	-0.353	-0.364	0.130	0.002	81
9. USE_EPM_INT	3.25	1.54	1.00	7.00	1.00	6.90	0.329	-0.957	0.134	0.001	81
10. USE_EPM_EXT	3.60	1.72	1.00	7.00	1.00	6.80	0.081	-1.169	0.127	0.003	81
11. ENV_PER	2.94	1.08	1.00	5.00	1.00	4.83	-0.385	-1.089	0.141	0.001	74
12. ORG_PER	2.08	0.83	1.00	5.00	1.00	4.00	0.336	-0.780	0.117	0.014	74
13. SIZE_ORG (log)	8.25	1.96	na	na	4.70	11.74	na	na	na	na	81

Notes: na = not applicable
[a)] Test of normality uses Kolmogorov-Smirnov statistics with Lilliefors significance correction.

Table E.7 – Correlations among variables

Variables	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
1. ENV_STR		0.86	0.77	0.85	0.82	0.57	-0.48	0.52	0.79	0.80	0.76	0.52	0.23*
2. EMIS_AVA	0.87		0.73	0.82	0.78	0.58	-0.35	0.50	0.82	0.77	0.73	0.47	0.14
3. EMIS_SCO	0.78	0.73		0.80	0.76	0.48	-0.37	0.39	0.65	0.65	0.60	0.34	0.28*
4. EMIS_TIM	0.84	0.81	0.83		0.80	0.57	-0.39	0.50	0.72	0.66	0.63	0.43	0.21
5. EMIS_ACC	0.81	0.78	0.77	0.82		0.49	-0.30	0.37	0.64	0.68	0.61	0.39	0.14
6. EPM_SEN	0.58	0.58	0.49	0.56	0.52		-0.36	0.58	0.60	0.56	0.63	0.55	0.15
7. EPM_PRE	-0.53	-0.38	-0.36	-0.40	-0.33	-0.45		-0.54	-0.48	-0.47	-0.55	-0.48	-0.21
8. EPM_CON	0.53	0.51	0.41	0.51	0.41	0.60	-0.58		0.49	0.41	0.51	0.47	0.16
9. USE_EPM_INT	0.78	0.82	0.62	0.70	0.62	0.58	-0.48	0.49		0.71	0.72	0.59	0.25*
10. USE_EPM_EXT	0.81	0.78	0.61	0.64	0.67	0.53	-0.47	0.41	0.72		0.75	0.51	0.25*
11. ENV_PER	0.79	0.77	0.68	0.67	0.62	0.67	-0.57	0.54	0.74	0.74		0.62	0.23*
12. ORG_PER	0.54	0.50	0.44	0.38	0.45	0.56	-0.47	0.47	0.62	0.54	0.64		0.14
13. SIZE_ORG	0.21	0.13	0.21	0.17	0.10	0.10	-0.19	0.14	0.27*	0.22	0.21	0.12	

Note: The figures below the diagonal report Pearson correlation coefficients. The figures above the diagonal report Spearman correlation coefficients. All correlations in the table are significant at 1% level (two-tailed), except those with an asterisk (significant at 5% level, two-tailed) or those underlined (not statistically significant).

Table E.8 – Comparisons of means between *reactive* and *proactive* environmental strategy

	***Reactive* environmental strategy** (*n* = 40)	***Proactive* environmental strategy** (*n* = 37)	**ANOVA *F***
Variables:			
EMIS_AVA	2.01	3.82	178.3**
EMIS_SCO	2.55	3.90	53.4**
EMIS_TIM	2.30	4.19	88.6**
EMIS_ACC	2.18	3.66	82.3**
EPM_SEN	2.40	3.30	30.5**
EPM_PRE	3.13	2.54	15.5**
EPM_CON	2.80	3.57	13.2**
USE_EPM_INT	2.19	4.35	70.4**
USE_EPM_EXT	2.27	4.95	126.3**
ENV_PER	2.19	3.74	74.8**
SIZE_ORG (log)	8.08	8.43	1.0
Sample characteristics:			
Integration of EMIS in accounting system	1.48	2.68	29.7**
Ownership of EMIS by controller	1.30	1.70	5.8*
TQM implementation	2.28	3.39	7.5
ISO 9000	3.58	4.42	4.0*
ISO 14001	0.92	3.25	16.2**

** Statistically significant at the 1% level, two-tailed test.
* Statistically significant at the 5% level, two-tailed test.

Table E.9 – Analysis of non-response bias: independent *t*-test

Variables	*Mean (s.d.)*		*t-values*	*p-values (two-tailed)*
	Early respondents	*Late respondents*		
ENV_STR	2.92 (1.06)	2.88 (0.98)	-0.16	0.876
EMIS_AVA	3.05 (1.13)	2.77 (1.07)	-1.17	0.244
EMIS_SCO	3.30 (1.33)	3.13 (1.12)	-0.67	0.505
EMIS_TIM	3.32 (1.33)	3.19 (1.31)	-0.45	0.655
EMIS_ACC	2.94 (0.87)	2.87 (1.03)	-0.28	0.781
EPM_SEN	2.86 (0.87)	2.81 (0.85)	-0.24	0.811
EPM_PRE	2.89 (0.81)	2.87 (0.74)	-0.16	0.874
EPM_CON	3.14 (0.98)	3.21 (1.01)	0.32	0.752
USE_EPM_INT	3.35 (1.59)	3.09 (1.51)	-0.71	0.478
USE_EPM_EXT	3.72 (1.79)	3.43 (1.69)	-0.74	0.464
ENV_PER	2.97 (1.12)	2.87 (1.05)	-0.39	0.692

Table E.10 – Analysis of non-response bias: Mann-Whitney U-test

Variables	*Mann-Whitney U-test*	*Wilcoxon W*	*Z-values*	*Asymp. p-values (two-tailed)*
ENV_STR	682.50	1502.50	-0.186	0.853
EMIS_AVA	646.00	1466.00	-1.315	0.188
EMIS_SCO	699.00	1519.00	-0.796	0.426
EMIS_TIM	636.00	1456.00	-1.415	0.157
EMIS_ACC	722.00	1542.00	-0.573	0.567
EPM_SEN	733.50	1553.50	-0.460	0.645
EPM_PRE	765.50	1585.50	-0.143	0.887
EPM_CON	759.50	1579.50	-0.203	0.839
USE_EPM_INT	721.00	1541.00	-0.392	0.695
USE_EPM_EXT	744.50	1524.50	-0.350	0.726
ENV_PER	704.50	1524.50	-0.741	0.459

APPENDIX F

Additional analyses of survey data

Table F.1 – Analysis of mediation effects

Step 1): Direct effects of ENV_STR on EMIS dimensions and EPMs properties

Dependent variable	*Beta coefficient*	*t-value*	R^2
EMIS_AVA	0.874	35.839**	0.75
EMIS_SCO	0.744	13.431**	0.57
EMIS_TIM	0.828	24.294**	0.68
EMIS_ACC	0.813	21.673**	0.64
EPM_SEN	0.592	7.919**	0.35
EPM_PRE	-0.525	7.565**	0.30
EPM_CON	0.582	7.854**	0.34

Notes: sample size n = 81. The results are obtained with PLS Graph using 500 bootstrap runs. Control variable SIZE does not show significant paths with any variable.
** significant at 1% level (one-tailed); * significant at 5% level (one-tailed).

Step 2a): Direct effect of ENV_STR on USE_EPM_INT

Dependent variable	*Beta coefficient*	*t-value*	R^2
USE_EPM_INT	0.762	20.938**	0.63

Notes: sample size n = 81. The results are obtained with PLS Graph using 500 bootstrap runs. Control variable SIZE shows significant paths with ENV_STR (β = 0.217, p<0.05) and with USE_EPM_INT (β = 0.103, p<0.05).
** significant at 1% level (one-tailed); * significant at 5% level (one-tailed).

Step 2b): Direct effect of ENV_STR on USE_EPM_EXT

Dependent variable	*Beta coefficient*	*t-value*	R^2
USE_EPM_EXT	0.801	23.108**	0.66

Notes: sample size n = 81. The results are obtained with PLS Graph using 500 bootstrap runs. Control variable SIZE shows a significant path with ENV_STR (β = 0.217, p<0.05).
** significant at 1% level (one-tailed); * significant at 5% level (one-tailed).

Step 3a): Direct effect of EMIS sophistication and EPMs properties on USE_EPM_INT

Independent variable	*Beta coefficient*	*t-value*
EMIS_AVA	0.712	5.630**
EMIS_SCO	-0.056	0.532
EMIS_TIM	-0.076	0.516
EMIS_ACC	-0.057	0.507
EPM_SEN	0.153	1.888*
EPM_PRE	-0.165	1.809*
EPM_CON	-0.065	0.637

Notes: sample size n = 81. The results are obtained with PLS Graph using 500 bootstrap runs. Control variable SIZE shows a significant path with USE_INT (β = 0.140, p<0.01), EMIS_SCO (β = 0.212, p<0.05), EPM_PRE (β = -0.185, p<0.05) and EMIS_TIM (β = -0.167, p<0.1).
** significant at 1% level (one-tailed); * significant at 5% level (one-tailed).

Step 3b): Direct effect of EMIS sophistication and EPMs properties on USE_EPM_EXT

Independent variable	*Beta coefficient*	*t-value*
EMIS_AVA	0.682	6.983**
EMIS_SCO	0.040	0.333
EMIS_TIM	-0.161	1.027
EMIS_ACC	0.240	1.878*

Notes: sample size n = 81. The results are obtained with PLS Graph using 500 bootstrap runs. Control variable SIZE shows a significant path with USE_EPM_EXT (β = 0.116, p<0.05),
EMIS_SCO (β = 0.208. p<0.05) and EMIS_TIM (β = -0.167. p<0.1).
** significant at 1% level (one-tailed); * significant at 5% level (one-tailed).

Table F.2 – Test of hypothesized relationships for lower organizational levels: standardized path coefficients and *t*-values (in parentheses)

	Paths to: 1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
	Adjusted R^2 for endogenous variables									
Paths from:	0.06	0.74	0.72	0.70	0.70	0.34	0.38	0.40	0.79	0.80
1. ENV_STR		0.869** (25.477)	0.758** (13.378)	0.836** (19.660)	0.842** (19.200)	0.588** (5.424)	-0.556** (6.341)	0.640** (7.773)	0.036 (0.179)	0.174 (1.064)
2. EMIS_AVA									0.717** (4.262)	0.468** (4.217)
3. EMIS_SCO									-0.082 (0.463)	0.121 (0.799)
4. EMIS_TIM									0.088 (0.435)	-0.082 (0.532)
5. EMIS_ACC									0.019 (0.127)	0.292* (1.959)
6. EPM_SEN									0.088 (0.973)	
7. EPM_PRE									-0.036 (0.296)	
8. EPM_CON									-0.008 (0.051)	
9. USE_EPM_INT										
10. USE_EPM_EXT										
11. SIZE_COM (control variable)	0.237* (1.804)	-0.051 (0.711)	0.241 (3.553)	-0.011 (0.131)	-0.012 (0.218)	-0.042 (0.373)	-0.167‡ (1.342)	-0.007 (0.234)	0.175** (2.422)	0.025 (0.305)

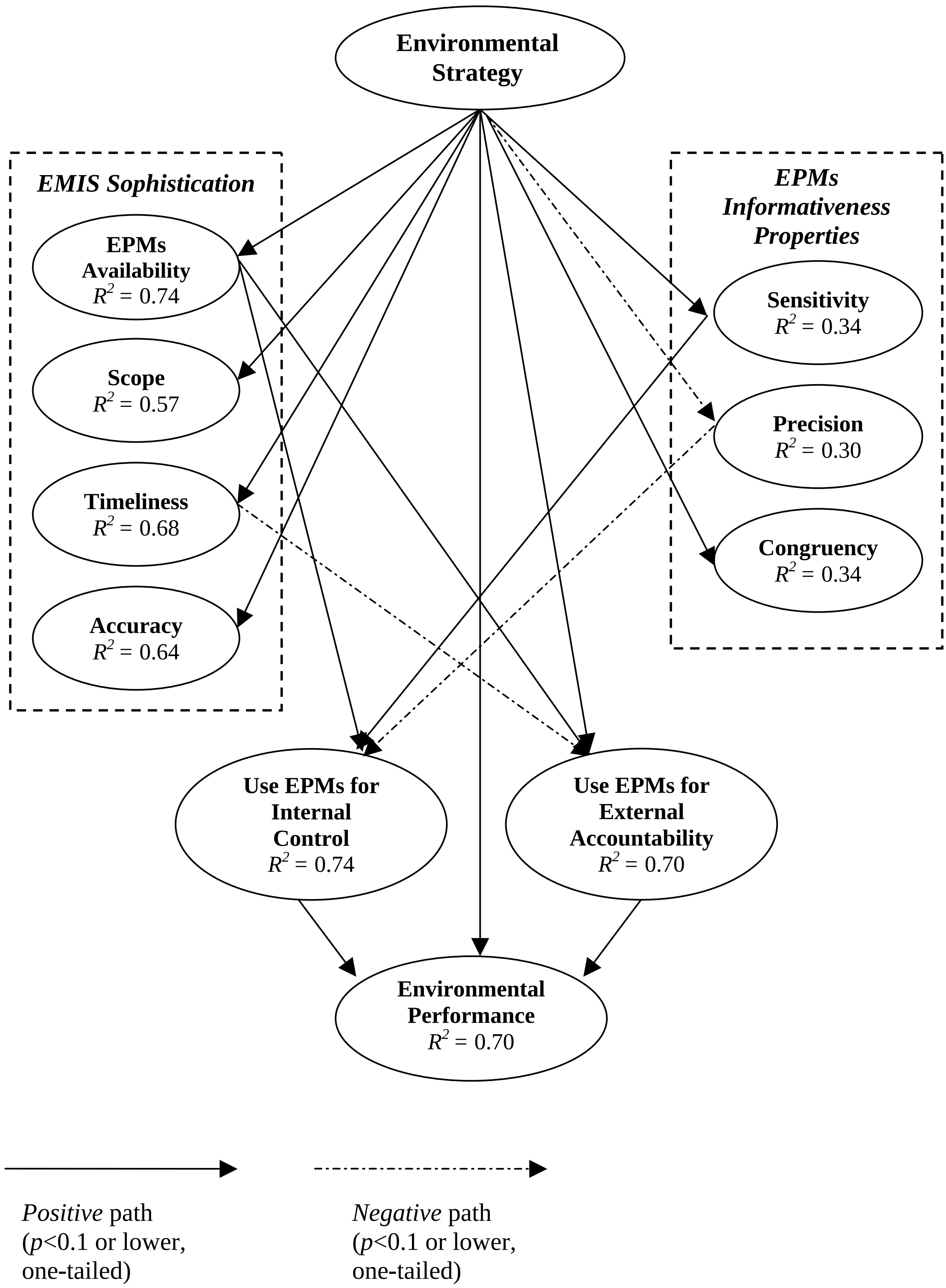
Notes: Sample size n = 53 (data collected at divisional and operational levels). The results are obtained with PLS Graph using 500 bootstrap runs. ** significant at 1% level (one-tailed); * significant at 5% level (one-tailed); ‡ significant at 10% level (one-tailed).

Table F.3 – Modified PLS model with *use of EPMs for decision-control* as dependent variable: standardized path coefficients and *t*-values (in parentheses)

	Paths to:									
	1.	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**	**10.**
	Adjusted R^2 for endogenous variables									
Paths from:	0.05	0.74	0.57	0.68	0.64	0.34	0.29	0.33	0.67	
1. ENV_STR		0.870** (34.079)	0.742** (13.330)	0.826** (23.823)	0.813 (21.433)	0.585** (7.573)	-0.523** (7.617)	0.579** (7.853)	0.394** (2.393)	
2. EMIS_AVA									0.523** (3.410)	
3. EMIS_SCO									-0.110 (0.865)	
4. EMIS_TIM									-0.001 (0.005)	
5. EMIS_ACC									-0.177‡ (1.508)	
6. EPM_SEN									0.178* (1.974)	
7. EPM_PRE									-0.039 (0.346)	
8. EPM_CON									-0.044 (0.358)	
9. USE_EPM_DC										
10. SIZE_COM (control variable)	0.214* (1.922)	-0.060 (1.112)	-0.051 (0.762)	-0.009 (0.153)	-0.073‡ (1.569)	-0.012 (0.128)	-0.070 (0.735)	-0.004 (0.047)	0.169** (2.607)	

Notes: Sample size *n* = 81. The results are obtained with PLS Graph using 500 bootstrap runs. ** significant at 1% level (one-tailed); * significant at 5% level (one-tailed); ‡ significant at 10% level (one-tailed)

Figure F.1 – Output of PLS structural model including *environmental performance*



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SUMMARY IN DUTCH (NEDERLANDSE SAMENVATTING)

Dit proefschrift beschrijft een tweetal empirische onderzoeken naar het gebruik van milieuprestatiemaatstaven in management control systemen (MCS). Omdat ondernemingen MCS trachten te implementeren die het bereiken van ondernemingsdoelstellingen beter ondersteunen, krijgt de problematiek omtrent prestatiemeting, prestatiebeoordeling en prestatiebeloning meer aandacht. Van oudsher hebben ondernemingen gesteund op financiële prestatiemaatstaven om de prestaties van medewerkers te bewaken en feedback te leveren. Daarnaast kunnen werknemers gemotiveerd worden door hun beloning afhankelijk te maken van deze financiële prestatiemaatstaven. Zowel academici als professionals zijn inmiddels echter van mening dat het gebruik van uitsluitend financiële prestatiemaatstaven niet langer toereikend is voor deze ondernemingsdoelstellingen. Niet-financiële-prestatie indicatoren zijn noodzakelijk om het strategisch en operationeel succes van onderneming te meten, en de aandacht voor de invloed van milieuprestatiemaatstaven als voorbeeld van niet-financiële-prestatie indicatoren is de afgelopen jaren toegenomen. Ondernemingen passen meer en meer het accounting systeem aan om te voldoen aan de interne vraag naar milieugerelateerde informatie om beslissingen te nemen en activiteiten te beheersen in overeenstemming met bestaande milieuregelgeving. Ook als gevolg van de huidige discussie over aandeelhouderswaarde (“shareholder value”) is de aandacht voor milieuaccounting binnen de onderneming langzaam maar zeker toegenomen en centraler in managementdiscussies komen te staan. Hierbij breekt het besef door dat milieuaangelegenheden niet langer kunnen worden gezien als randvoorwaarden voor de bedrijfsvoering, maar steeds meer als een normaal onderdeel van de strategieformulering door ondernemingen moeten worden beschouwd. Het milieu heeft invloed op de “bottom line”.

“Environmental management control” refereert in dit proefschrift aan het pakket van formele en informatiegebaseerde procedures die managers gebruiken om de milieukundige aspecten van ondernemingsprestaties te beheersen. Ondanks fragmentarisch bewijs voor de invoering van environmental management control, is er relatief weinig onderzoek verricht naar dit onderwerp. Voorgaand onderzoek in het vakgebied milieuaccounting heeft zich voornamelijk gericht op (externe) milieuverslaggeving, waarbij grotendeels werd voorbijgegaan aan (interne) management accounting en aan de beheersingsaspecten van milieumanagement.

Zoals in Hoofdstuk 1 wordt uiteengezet, is het doel van dit proefschrift om deze leemte in het vakgebied management accounting en control te vullen. In dit proefschrift worden de rol en de implicaties van MCS in milieumanagement nader bestudeerd en is de blik gericht op het ontwerp en gebruik van milieuprestatiemaatstaven ("environmental performance measures" - EPMs). Drie onderwerpen worden onderscheiden. Ten eerste onderzoekt het proefschrift de determinanten en het gebruik van EPMs. Het doel is de variatie te verklaren in de omvang en manier van gebruik van EPMs. Immers, de geringe beschikbare gegevens suggereren dat ondernemingen verschillende stadia van implementatie en gebruik van EPMs doormaken. Ten tweede verkent deze studie de prestatie-effecten gerelateerd aan het gebruik van EPMs in MCS. Deze studie presenteert een empirische analyse van de hypothese uit onderzoek gebaseerd op de contingentiebenadering dat de overeenstemming tussen milieustrategie en het gebruik van EPMs ondernemingsprestatie positief beïnvloedt. Ten derde en ten slotte bestudeert dit proefschrift de organisatorische dynamiek gerelateerd aan veranderingen in het MCS. Het doel is om de procesmatige aspecten die de implementatie van een milieuprestatiemeetsysteem teweeg brengt te begrijpen. In het bijzonder is het doel van deze studie op het verkrijgen van inzicht in de bijdrage van management accounting en control aan de integratie van EPMs in traditionele MCS.

In Hoofdstuk 2 wordt het onderzoeksdomein geïntroduceerd en gepositioneerd door middel van een literatuuroverzicht van het (multidisciplinaire) onderzoek in milieumanagement en milieuaccounting. Dit overzicht leidt tot het identificeren, organiseren en evalueren van de twee relevante onderzoeksgebieden. Het overzicht illustreert tevens hoe de hoge mate van fragmentatie van onderzoek uit de verschillende academische disciplines betreffende milieuprestatiemeting en -beheersing het vormen van een coherente kennis belemmert. Het overzicht stelt vast dat voorgaand academisch onderzoek in dit vakgebied met veel problemen te kampen heeft en nog in een pioniersfase verkeert. Bovendien stelt het vast dat het onderzoek op het gebied van externe milieuverslaggeving aanzienlijk uitgebreider is dan het onderzoek naar environmental management control. Daarom gebruikt het proefschrift de empirische literatuur over de keuze van prestatiemaatstaven vanuit de algemene management accounting literatuur.

In Hoofdstuk 3 wordt een conceptueel model gepresenteerd, dat de omvang en manier van gebruik van milieuprestatiemaatstaven bespreekt. Vervolgens worden een aantal testbare hypotheses ontwikkeld. Het model combineert twee paradigma's uit de management accounting literatuur, gericht op het ontwerp en gebruik van prestatiemeetings- en beheersingsystemen. Ten eerste bouwt het model voort op contingentietheorie uit voorgaande “gedragsmatige” studies waarin de interacties tussen operationele strategie en het MCS-ontwerp werden onderzocht. Zoals blijkt uit het literatuuroverzicht is het hierbij bijzonder nuttig om te refereren aan de literatuur over kwaliteitsmanagement, vanwege de conceptuele en praktische analogieën tussen het vakgebied kwaliteitsmanagement en milieumanagement. Het model stelt dat de milieustrategie van een onderneming een relevante voorspeller is van het gebruik van EPMs. In het bijzonder stelt het model dat er een indirect effect bestaat tussen strategie en MCS door een set van karakteristieken van het informatiesysteem. Ten tweede benadrukken recente overzichten in de empirische management accounting literatuur dat de verklaring voor de keuze van prestatiemaatstaven volgens de “gedragsmatige” literatuur nuttig geïntegreerd kan worden met verklaringen volgens de economische agency literatuur. Derhalve worden hypothesen ontwikkeld om te verkennen hoe de incrementele informatie waarde (“informativeness”) van prestatiemaatstaven geassocieerd is met het gebruik van EPMs. Verder is de manier van het gebruik van EPMs onderwerp van het ontwikkelen van theorie door een verschil te maken tussen enerzijds het gebruik van EPMs intern voor het nemen en het beheersen van beslissingen en anderzijds het gebruik van EPMs extern voor verantwoordingsdoelstellingen (“accountability”) richting belanghebbenden en aandeelhouders van de onderneming. Dit onderscheid is van groot belang voor het vakgebied environmental management control, gegeven dat de leemte tussen de twee manieren van gebruik (het zogenaamde “window dressing” of “greenwashing” effect), de reputatie van ondernemingen richting externe belanghebbenden negatief zou kunnen beïnvloeden. Ten slotte geeft dit proefschrift een theoretische analyse van de consequenties van de combinatie van een bepaalde milieustrategie en het gebruik van EPMs. De analyse van deze laatste relatie maakt het mogelijk inzicht te verschaffen in de rol van EPMs bij het totstandbrengen van overeenstemming (“fit”) tussen milieustrategie en milieuprestatie.

Zoals beschreven is in Hoofdstuk 4 zijn voor het eerste empirische onderzoek gegevens verzameld door middel van een enquête. Deze enquête was deel van een onderzoeksprogramma gesponsord door het Controllers Instituut (CI) dat zich richtte op het verkrijgen van informatie over de performance management praktijk in Nederland. In totaal is aan 285 controllers en financieel managers, werkzaam in Nederlandse productieondernemingen, een enquête gestuurd. De uiteindelijke steekproef bestond uit 81 respondenten, wat gunstig afsteekt bij soortgelijke studies. In Hoofdstuk 6 wordt het tweede empirische onderzoek beschreven, dat een case studie betrof die bij een Europese multinational in de chemische sector is uitgevoerd. Het doel van deze case studie is tweeledig. In de eerste plaats is deze bedoeld om de bevindingen van de resultaten uit de enquête te complementeren door het conceptuele model uit Hoofdstuk 3 ook kwalitatief te testen. Het longitudinale ontwerp van de case studie stond toe dat het proces van MCS veranderingen, de wijziging van het milieuprestatiesysteem, ook dynamisch in plaats van comparatief-statisch kon worden geobserveerd. De twee uitgevoerde empirische studies verschaffen in combinatie bewijs van de determinanten, consequenties en procesmatige aspecten van het gebruik van EPMs in MCS.

De resultaten van de enquête en de case studie worden geanalyseerd in de Hoofdstukken 5 en 6. De bevindingen ondersteunen grotendeels de rol van strategie als een relevante contingentiefactor die de keuze van prestatiemaatstaven beïnvloedt. In overeenstemming met de verwachtingen blijkt dat ondernemingen die meer aandacht besteden aan milieustrategie geneigd zijn om een uitgebreidere set van EPMs te ontwikkelen. Deze bevindingen liggen in lijn met eerder management accounting onderzoek gebaseerd op de contingentie benadering, waarin gesteld wordt dat een zogenaamd “congruentie type van fit” aanwezig dient te zijn tussen de keuze van strategie en het ontwerp en gebruik van MCS. Verder suggereren de resultaten dat de aanwezigheid van een duidelijk geformuleerde milieustrategie niet voldoende is om de implementatie van deze milieustrategie te verzekeren. Met andere woorden, hoewel strategie beschouwd kan worden als een noodzakelijke factor bij de keuze voor prestatiemaatstaven, dienen EPMs voldoende kwaliteit en betrouwbaarheid te tonen voordat ze in MCS gebruikt kunnen worden. De resultaten tonen de sterke behoefte aan “het goed ontwerpen van het informatiesysteem”, voordat de beschikbare prestatiemaatstaven aangewend kunnen worden voor interne beheersdoeleinden.

In Hoofdstuk 5 worden de data van de enquête geanalyseerd middels *structural equations modelling.* De resultaten laten zien dat specifieke ontwerpeigenschappen van milieuprestatiemeetsystemen een indirect effect hebben op het gebruik van EPMs. De beschikbaarheid van EPMs medieert de relatie tussen milieustrategie en het gebruik van EPMs. Op soortgelijke wijze kan deze relatie worden verklaard door de waargenomen gevoeligheid (“sensitivity”) die managers aan deze prestatiemaatstaven toekennen.

Verder worden de data van de enquête gebruikt om de prestatieconsequenties, als gevolg van het gebruik van EPM, te verkennen. De bevindingen uit de enquête bevestigen de aanwezigheid van een mediërend type van “fit”, aangezien de milieustrategie de milieuprestatieniveaus positief beïnvloedt via het gebruik van EPMs voor interne beheersing. Twee aspecten maken het bestuderen van de verbanden tussen strategie, MCS en prestaties in dit vakgebied problematisch. Ten eerste, door het ontbreken van duidelijke definities van de multidimensionele aspecten van milieuprestaties, wordt het identificeren en meten van de afhankelijke variabele (prestaties) lastig. Ten tweede vormt het conceptueel modelleren van causale relaties in dit vakgebied een uitdaging, omdat “leading-lagging” effecten rond vervuilingproblematiek moeilijk te detecteren zijn. De studie concludeert dat de gekozen longitudinale aanpak in de case studie een mogelijke bijdrage kan leveren aan het oplossen van deze controverse en dat toekomstige studies zorgvuldig moeten worden ontwikkeld zodat deze aanvullende betrouwbare data opleveren.

Ten slotte benadrukt de case studie dat metinggerelateerde factoren een belangrijke rol spelen in de implementatie en het gebruik van milieuprestatiemeetsystemen. In het algemeen kan gesteld worden dat moeilijkheden in het definiëren en ontwikkelen van geschikte prestatiemaatstaven voor moeilijk te meten activiteiten een ernstige belemmering vormen voor de implementatie van innovatieve MCS. Zoals bleek uit de case studie verkeert het standaardisatieproces geassocieerd met EPMs nog in een vroeg stadium in vergelijking met de standaardisatie van andere niet-financiële maatstaven. Daarnaast suggereren de bevindingen uit de case studie dat de complexiteit van procesmatige elementen van verandering binnen organisaties in dit vakgebied inderdaad aandacht verdient. Een combinatie van interne factoren op verschillende hiërarchische niveaus droeg bij aan het initiëren van het veranderingsproces. De betrokkenheid van zowel de directie als van het personeel van de milieuafdeling leken cruciale voorwaarden om de verandering van het MCS te ondersteunen. De samenwerking tussen milieu- en accountingpersoneel bleek van belang om de verandering in het beslissings- en control mechanisme te faciliteren. Tegelijkertijd vervulden autonome ontwikkelingen in de institutionele omgeving een rol als belangrijke sturende factoren. De ontwikkelingen bij de onderneming waar de case studie werd verricht suggereren dat de inertie voortkomend uit de institutionele context dominant zou kunnen zijn, ondanks de aanwezigheid van factoren die als katalysator zouden kunnen werken binnen een organisatie. Deze resultaten helpen begrijpen waarom slechts een kleine minderheid van ondernemingen reeds een formeel milieuprestatiemeetsysteem heeft geïntegreerd in het traditionele MCS. Enkele ondernemingen kiezen er vanuit een strategisch oogpunt voor om geen personele- en financiële middelen te investeren in meer gesofisticeerde EPMs vanwege het ontbreken van stabiele en duidelijke standaarddefinities. Samenvattend suggereren de bevindingen dat het veranderen van prestatiemeetings- en beheersingsystemen in dit gebied problematischer is dan in andere contexten zoals kwaliteitsmanagement.

Het proefschrift wordt afgesloten met Hoofdstuk 7, waarin de beperkingen van deze studie samengevat worden en richtingen voor toekomstig onderzoek naar de rol en de implicaties van management accounting en control in milieumanagement worden voorgesteld.

CURRICULUM VITAE

Paolo Perego graduated in Business Administration at Bocconi University of Milan in 1996 with a thesis about the evaluation and the economic impact of environmental liabilities. He obtained a European Master's degree in Environmental Management in 1997 at the Ecole Polytechnique Fédérale de Lausanne. After a period of internship at Ecobilan Italy in Milan, he was employed at ENI Agip Petroli in Genoa to assist the implementation of an ISO 14001 environmental management system in three oil facilities in Italy. Subsequently he worked as junior manager at URS Dames & Moore in Rome where he performed consultancy tasks in the area of environmental, quality and health & safety management. From July 1999 to December 2003 he was employed as Ph.D. student and lecturer in management accounting at the Department of Business Studies of the University of Amsterdam. From January 2004 to May 2005 he worked at the Department of Economics of the Radboud University Nijmegen, where he finalized this dissertation. Since June 2005 he is an assistant professor of management accounting at the Rotterdam School of Management. His research and teaching interests include management accounting and control, environmental accounting and sustainable management.